Journal of Chemical Education

Published by
Section of Chemical Education of The American Chemical Society
Easton, Pa.

Entered as Second-class Matter, January 31, 1924, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized January 31, 1924.

Vol. II **June, 1925** **No. 6**

CONTENTS

	Page
Editor's Outlook	428
Synthetic Methanol—An Accomplishment of Chemical Research. Carl R. DeLong	429
The Direct Applications of Chemistry in the Study and Practice of Medicine. Arthur D. Hirschfelder	431
Some Chemical Products of Florida. Walter H. Beisler	437
Demonstration Apparatus for the Simultaneous Preparation of the Halogens. Raymond Szymanowitz	440
Group Examinations in Chemistry. Frank C. Whitmore	441
The Art of Lecture Table Demonstrating. H. F. Davison	443
Some Suggested Changes in High-School Chemistry. George Mervin Browne	447
Introduction to the Systematic Treatment of First Year Chemistry. P. M. Glasoe	449
Benjamin Hale—Professor of Chemistry and College President. Lyman C. Newell	457
Uses of Ethylene. F. B. Arentz	459
Chemical Spelling. C. A. Jacobson	462
A Classification of the Elements with Respect to Their Properties. H. A. Geauque	464
Suggestions to the Teacher of Chemistry on Poisons and Their Treatment. R. G. Turner	466
The Problem of High-School Chemistry. Guy Clinton	471
The Teaching of Science in the High School. Jessie Spencer	476
Museum Reactions. R. A. Baker	480
Manipulation of Gas Holders by Elementary Chemistry Students. C. A. Brautlecht	486
An Apparatus for Conductivity Experiments. Harry Clifford Doane	487
A Grading Help. John A. Michener	488
A Laboratory Note Book. Walter O. Walker	489
New Apparatus for Determining the Coefficient of Expansion of Gases. W. H. Chapin and R. N. Maxson	490
The Effect of the Equal Pay for Teachers Bill in New York State. Ernest N. Pattee	493
The Calculation of the Formula of a Compound from Its Percentage Composition. James Kendall	495
The Periodic Law. A Bedtime Story for Wide Awake Children. Eleanor Erwin	497
An Adjustable Atomic Model. G. O. Higley	499
Classroom Emanations	501
List of A. C. S. Prize Winners 1924-25	502
Chemical Digest; Abstracts	505
Report on Evaluation of Objectives in Chemistry Education	
Hydrogen Sulfide Gas	
Design of a Chemical Research Laboratory	
Experiments with Explosive Gas Mixtures	
Elements of Glass Blowing and Demonstrations	
Pioneering in the Chemistry of Microbes	
The Results of the Application of Science in the Field of Medicine	
Recent Developments in the Nitrogen-Fixation Industry	
Fading of Dyed Materials	
Speeds of Atomic Particles	
Chance in Experimenting	
Aluminum Paint for Oil Tanks	
Pure Silvery Aluminum	
Artificial Food	
Playing the Game in the College Classroom	
The Place of Religion in Higher Education	
The Articulation of General Science with the Special Sciences	
Pasteur. (Editorial entitled "Worship Great Men.")	
Local Activities and Opportunities	511
Recent Books	514

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY

EDITOR'S OUTLOOK

Let us prepare for the growth that is characteristic of our science. We have only to read the article in *This Journal* by Dr. DeLong to see how easily our teaching may become antiquated. We must be wide-awake to the present, peering as far as possible into the future if we are to keep abreast with the development of our great science.

SYNTHETIC METHANOL—AN ACCOMPLISHMENT OF CHEMICAL RESEARCH

CARL R. DELONG, WASHINGTON, D. C.

Nothing in recent years has brought chemical research so forcibly to the attention of the chemical industry as the production of synthetic methanol (wood alcohol). It had been rumored for some time past that a process had been developed in Germany for the synthesis of methanol. The importation into the United States of large quantities of this product from Germany during the first three months of 1925 confirmed these rumors and demonstrated that synthetic methanol was an accomplished fact. As a result of research started in the production of synthetic hydrocarbons for use as motor fuels by catalytic hydrogenation of carbon monoxide the Germans discovered that under certain conditions methanol was produced. Further research work on the optimum conditions as to temperature, pressure and catalysts has improved this process to a point where the production of methanol from carbon monoxide and hydrogen is a commercial accomplishment.

Imports of synthetic methanol into the United States during the first three months of 1925 have amounted to 101,784 gallons with a value of 48.5 cents per gallon landed at Atlantic ports without payment of duty. The duty of 12 cents per gallon added to this makes a total cost of 60.5 cents per gallon. The present price of domestic methanol is about 75 cents per gallon.

The production of methanol by this process, at a cost well below that of producing methanol in the United States by the distillation of wood, will have far-reaching economic effects on the domestic industry and also upon the various industries which depend upon this essential raw material. The production of methanol and allied products in the United States from the distillation of hard woods was one of the first chemical industries established in this country.

According to Government reports, the primary products of this industry were valued at $30,000,000 in 1923. The industry employed 4022 wage earners who were paid wages amounting to $4,240,000 per annum. The latest figures (1919) of the capital invested in the industry are $42,235,000. Additional capital invested in refining the crude methanol produced and in the conversion of acetate of lime into acetic acid and acetone would undoubtedly increase this investment to somewhere between 50 and 75 millions of dollars.

The manufacture of synthetic methanol either in Germany or in the United States offers a serious threat to the wood chemical industry. Indeed it is probable that within a very few years the production of synthetic methanol will have become so well established in this country that the major portion of the domestic supply will be synthesized. This does not

mean that the wood chemical industry will be wiped out overnight, as the process of shifting from production of the natural methanol to the synthetic product will take several years.

This development will also have a widespread effect on various other chemical industries in the United States which consume methanol. Cheaper synthetic methanol means cheaper formaldehyde which, in turn, will reduce the cost of manufacturing synthetic phenolic resins, such as bakelite. The use of these resins in place of wood is unlimited if the cost can be lowered. Lower prices for methanol will also open up a new and broader field for its use as a solvent.

The development of synthetic methanol in the United States must be accompanied by the production of synthetic acetic acid which is produced jointly with it in the distillation of wood. Fortunately the manufacture of synthetic acetic acid has been worked out, and the industry is already well established on a large commercial scale in Canada and Europe. The introduction of the manufacture of synthetic acetic acid in the United States will be reflected in appreciable saving in transportation costs. Acetic acid as produced synthetically is over 99 per cent pure. The saving in freight rates through shipment of the concentrated product instead of the weaker grades produced from wood chemical acetate of lime will be considerable.

The development of synthetic methanol parallels in many respects the successful production of synthetic indigo and synthetic phenolic resins (amber substitutes). Here, again, the chemical industry has by synthesis produced a product which is cheaper than that from natural sources and which surpasses the natural product in purity and uniformity. Shipments of synthetic methanol have been proven by actual manufacturing tests to be equal in every way to the natural product, and meet the most rigid specifications of the consuming industry.

Although the introduction of synthetic methanol in the United States will probably mean a great loss of investment in the wood chemical industry, it is hoped that it will serve as an object lesson to other branches of the American chemical industry. Chemical research has too often been looked upon as an expensive luxury. It has been the policy of many chemical firms during periods of depression to retrench by cutting their research organizations. During such periods of keen competition a well organized and trained research staff offers the best possibility of reducing costs, improving products, and developing new products at a lower cost. Synthetic methanol is an outstanding example of what may be accomplished through scientific research when appreciated and supported by industrial chemical concerns and when properly coördinated with commercial developments.

It is to be hoped that this example will indelibly impress upon the chemical industry the importance of chemical research.

THE DIRECT APPLICATIONS OF CHEMISTRY IN THE STUDY AND PRACTICE OF MEDICINE*

ARTHUR D. HIRSCHFELDER, PROFESSOR OF PHARMACOLOGY, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

It is an everyday occurrence in the teaching of pharmacology and other branches of medicine to encounter some student who fails to understand the principles upon which the use of an important drug depends, even though it involves a well known chemical reaction which he has himself carried out in the laboratory in his course in chemistry. Under these circumstances he usually remarks, "If I had only known when I was taking chemistry that I was going to find a practical use for this, I might have learned it more thoroughly." And so I am going to tell you today a few of the things which you will do with your knowledge of chemistry when you study and practice medicine.

I have been asked to address you because I am *not* a teacher of chemistry, but one who has for years practiced medicine and who now teaches about the applications of drugs in the treatment of patients. I shall speak only of the things that find a use in everyday medical practice, though there are many other facts and theories which today seem to have purely theoretical interest, but which, in the next few years, will find practical applications that are at present not dreamed of.

A little over twenty years ago when I graduated from the Johns Hopkins Medical School a thoroughly up-to-date physician could carry most of his apparatus around in his coat pockets. How the most highbrow of us in those days would have laughed if some visionary had told us that before we were middle aged, every consultant in medicine would have in his office a technician who was trained in refinements of quantitative analysis equal to that of the best analyst, and that the diagnosis and treatment would depend more upon the findings of this analyst, who had never seen the patient, than upon the trained eye, ear and finger of the physician at the bedside! And yet exactly this has come to pass! It is the practice of medicine today.

And so, in taking a bird's eye or aeroplane view of the different fields of chemistry I would like to point out to you a few of the things that are actually in use today and that are as necessary to an understanding of present day medicine as is a knowledge of anatomy.

First, let us consider the field of general chemistry. How many of you realize that every beat of your heart sets in because your blood contains a very exactly balanced proportion of sodium, potassium and calcium ions, and that a trace too much of sodium or potassium would kill you at once unless more calcium were supplied to balance it? How many of you

* Lecture given, with slight modifications, to freshmen in the Course in General Chemistry for premedical students at the University of Minnesota, in October, 1922.

realize that an excess of magnesium salts injected under the skin or into a vein will put you to sleep so that a surgical operation could be performed; and, on the other hand, by a strange ion antagonism, you could be waked in an instant from this sleep by an injection of calcium salts? This same magnesium will relieve the convulsions of lockjaw or strychnine poisoning, or may be added to morphine to increase and prolong relief from pain. The ordinary barium sulphate which is formed in the determination of sulphuric acid is also mixed with the food of a test meal to cast shadows with the X-ray for the study of digestion in patients with stomach and intestinal troubles.

In 1839, James Blake of Edinburgh showed that in any single group of elements the drug action and poisonous actions of the element increased in proportion to the molecular weight, and so we find that the salts of the heavy metals (mercury, silver, etc.) act as strong antiseptics, and as intense poisons, which affect especially the cells of the kidneys. We also find that phosphorus and arsenic in large doses produce fatty degeneration of the heart, liver and kidneys; but that in infinitely small doses phosphorus stimulates the growth of bone and that arsenic stimulates the blood forming cells of the bone marrow in anaemia. Arsenic as a general poison is also poisonous to primitive cells, and its organic compounds are therefore used for treating infections with the trypanosome of sleeping sickness and the spirochete of syphilis.

In the treatment of poisoning with the heavy metals, too, we may make use of the simple reactions that are employed in qualitative analysis. Thus, many a man's life has been saved from bichloride of mercury poisoning by reducing the mercury in the stomach from the bivalent to the univalent form as calomel with reducing agents like sodium phosphite or by converting it into the insoluble sulphide by administering a pill of calcium sulphide.

Quantitative analysis, especially volumetric analysis, is absolutely necessary for the physician. We cannot diagnose and treat patients who have any disease of the stomach without careful quantitative analysis of the stomach contents; and the entire everyday treatment of a patient suffering from diabetes today depends upon determining the amount of the sugar in his blood by a method so delicate that it was impossible twenty years ago... Even the country doctor of today must be well versed in quantitative analysis.

When we pass to the field of physical chemistry, we come into a realm of even greater promise and use in medicine. As in every other laboratory, the reactions that go on in the body, the digestion of food, the building up of foodstuffs into tissues, the oxidation of food products to liberate muscular energy, all follow the laws of mass action. However, the conditions of the reactions in the body are not as simple as they are for the re-

actions in the test tubes. The law of mass action also manifests itself in the distribution of drugs among the tissues of the body and this plays a role in determining the manner in which a substance will act when given as a drug. Thus, it was shown by Overton and Meyer that the cells of the body are surrounded by an armor of fat-like substances and that substances which are very soluble in the fat-like substances (the lipoids) which are present in largest quantities in the brain, are taken out of the blood by the brain lipoids in exactly the same manner as a substance can be extracted from water by shaking with ether in a separatory funnel. If the foreign substance is one which is chemically inert but more soluble in lipoids and in the common organic solvents than it is in water, it will produce anesthesia or sleep. If it is more soluble in water than in the organic solvents it is more likely not to enter the cells but to be excreted by the kidneys in the urine, or by the liver in the bile.

The cells, tissues, blood, lymph and tissue juices are all colloids, some emulsions, some suspensions and some jellies. We may think of every organ as a big mass of jelly—not a simple jelly like currant jelly, but one with all sorts of suspended particles, like marmalade or like custard. Since much of it contains fat-like particles it has much in common with mayonnaise salad dressing. With every nerve impulse, with every muscle contraction and with every disease process, there is a change somewhere in the system. Some of the surfaces may spread out as in the making of a mayonnaise, or some of the surfaces may contract so that the mayonnaise-like structure with its very minute droplets may be changed into larger drops like those of an ordinary French salad dressing... With every muscle contraction, a tiny droplet of lactic acid is formed from the sugar in the muscle. This acid causes a droplet of protein to take up water from the surrounding tissue juice. The muscle jelly swells and changes from a long cylinder to a shorter, more spherical mass and so the contraction of the muscle sets in. In diseases of the kidneys and of other organs too, the jellies in the cells of the organ take up more water, swell, press on the blood vessels and interfere with the function of the organ and the conditions of disease result. Such common diseases as hay fever, sensitiveness to drugs, and even the reactions of immunity by which we become sensitive to, or are able to combat the germs of disease, seem to depend largely upon the tendency of certain molecules to group themselves together into larger masses like little bunches of grapes or little bunches of bananas, or upon the tendencies of such bunches of molecules (colloidal micellae) to break up into smaller bunches. Possibly the changes in cells which lead to the formation of tumors and of cancer are bound up also with those properties of the surface layer of cells which cause them to stick together (surface tension), and with the changes in molecules which alter the size of the bunches in which they are packed in the body. In all these and many

other conditions we are dealing with the changes in mass and in surface and in the number of molecules which group themselves together which we call surface phenomena and colloid chemistry. They all obey the fundamental laws of colloids, and the more we know of colloid chemistry, the better we understand the phenomena of life, of disease, of treatment, and of death.

Even more important, perhaps, is the role of colloids among the medicines. Colloids like gum arabic (acacia) protect raw surfaces against irritants. Colloids like milk, egg albumen and typhoid vaccine, have been injected under the skin to cure chronic joint diseases and other chronic infections. Copper, sulphur and other simple elements in colloidal form have been injected into the veins by Leo Loeb and have caused definite but only temporary improvements in patients with cancer. The Wasserman reaction for the detection of syphilis and the Widal reaction for typhoid, are colloid phenomena. Ehrlich's salvarsan for the cure of syphilis, Nicolle and Mesnil's trypanblue by which trypanosome disease is cured in animals; the Baeyer 205 remedy which cures the dreaded sleeping sickness in Africa—in short, many of our drugs which are specific for the treatment of the infectious diseases, owe their action to their physical properties as colloids as well as to their purely chemical nature.

Just as every housekeeper knows that the proper amount of vinegar is important in making a mayonnaise dressing that will keep permanently and that the proper amount of soda (alkali) is important to preserve the properties of soap for laundering; so also to preserve life, the acids and alkalies in the body are most delicately balanced. This balance is so delicate that the blood is always kept on just the alkaline side of the neutral, at an alkalinity about equal to that of normal caustic soda diluted three million times with distilled water. If our blood should ever become as acid as the ordinary distilled water of the laboratory, or as alkaline as the tap waters emerging from most city faucets, we should die at once. The blood is kept near neutral by the presence of an ever-changing mixture of acid and alkaline salts, the phosphates, carbonates and bicarbonates. If it were not for the presence of these salts, breathing would stop. They act like little freight cars to carry carbonic acid and lactic acid to the lungs and kidneys, dump them there for excretion and then go back to the tissues for more. Some of the secretions like gastric juice and urine are acid, that is, rich in H ions; some like the pancreatic juice are alkaline, or rich in hydroxyl ions. Many diseases are produced by too much acid formed in some of the tissues, and these may be in part remedied by administering alkalies by mouth or into the veins. Some diseases, especially those in which there are convulsions, are accompanied by too much alkali; in these, acids may be given with benefit. All of these have been discovered by a very careful study of the concentration of hydrogen

ions in the blood of patients and animals, by the most elaborate methods of physical chemistry, and strange as it may seem, a very exact determination of the hydrogen-ion concentration of the patient's blood is today regarded as important in many diseases, as is the taking of the patient's temperature. So physical chemistry, too, is part of the doctor's daily routine!

But, however great is the importance of general chemistry and of physical chemistry in the body, the importance of organic chemistry is still greater. The digestion of our foods, the building up of our tissues, the breaking down of our tissues in exercise, in daily use and in disease, are all processes of organic chemistry, and most of the medicines which we use to control disease are organic substances.

Since it is impossible for any student to know all the facts about the hundreds of thousands of organic substances that are known, it is worth while to focus attention on a few of the reactions which play the greatest role in life phenomena, and a few of the most important groups of substances with which the student will be concerned in his medical career.

Perhaps the most important of all the chemical reactions that go on in the body are those which are concerned with union of two substances through the splitting of water, similar to that which occurs in simple esterification, and since these reactions are reversible we find almost equal importance in the reversed process, the hydrolytic splitting of one substance into two by taking up one molecule of water. The digestion of all our foods, of starch, of protein, or of fat, is a hydrolytic splitting, like the hydrolysis of an ester. Many medicines are given in the form of esters, but act in the form of their simpler compounds into which they are split in the body. They are given as esters because in that form they act more slowly, and are therefore less poisonous than the simpler products into which they are split. The building up of the proteins which constitute the bulk of our tissues is the reversed reaction, the union of several amino acids accompanied by the splitting off of water. The starches and the starch-like substance of the liver, glycogen, and also the fats, are built in a similar way.

The second important type of reactions are those which are concerned with oxidation and reduction, and here we must remember that the oxidations and reductions that go on in the body, go on step by step. As Traube and Bach, and Kastle and Loevenhart have shown, each step seems to be brought about by the intermediate production of an unstable organic peroxide similar to hydrogen peroxide, and so we should pay especial attention to the reactions of these organic peroxides as oxidizing agents. All sorts of oxidations go on in the body: sugar to lactic acid and then to CO_2, fats to aceto-acetic acid and then to CO_2, and many medicines to oxidation products which may be more poisonous, or less poisonous, than the medicines are themselves. Thus anilin and acetanilid (the

headache powder which you will make in the laboratory) are oxidized to para-aminophenol, which is less poisonous than the original substance, while arsphenamin (salvarsan) the syphilis remedy, is oxidized to arsinoxide which is more poisonous.

Whenever we introduce a drug into the body, we must consider what changes it will undergo in that great laboratory, usually changes that will involve either a giving off or taking up of water on the one hand, or an oxidation or a reduction on the other hand, in order that we may understand the form in which it will be present in the tissues and in which it may exert its beneficial or its poisonous actions.

Many of the substances in ordinary use in the organic chemical laboratory, and many that you synthesize in the routine laboratory course, are valuable medicines. The phenol, toluene and cresol that you use in the organic laboratories are excellent antiseptics; the salicylic acid and the methyl salicylate you make yourselves will relieve the pains of rheumatism; the benzyl alcohol can be used as a substitute for cocaine, and its esters, like benzyl benzoate, will relieve the pains of menstruation and the cramps of dysentery.

The war has given us Dakin's solution of free chlorine as an antiseptic to clear up infected wounds, and that same ingenious chemist has combined the chlorine into more stable compounds with sulphonamids to give us chloramin T and dichloramin T—still more useful antiseptics. The complex substance, hexamethylenamin tetramine, which is formed when ammonia and formaldehyde combine in alkaline solution, splits off its formaldehyde again in acid solutions, and can be given as a drug to circulate through the body to be excreted in the urine and disinfect infected bladders and kidneys. A host of organic substances, especially derivatives of urea, can be used to bring a quiet, restful sleep, and the more complex derivatives of aniline relieve pain. Most of the aniline dyes are strong antiseptics and many of them act much more strongly on one germ than on another so that in this group there lies the possibility of the specific cure of disease.

New and better drugs are made by starting with a substance which has the general action that we want, but is too weak or too poisonous, and then changing its molecule group by introducing stronger groups or less poisonous groups as the case may require—and then testing the activity of the substance. If this is promising, still further changes are introduced in the molecule to secure a still better substance. In this way Ehrlich tested 606 substances to secure arsphenamine (salvarsan); White and Young tested 220 substances before obtaining their fine antiseptic "mercurochrome," and the chemists of the Baeyer Company tried 205 compounds before they obtained their remedy for sleeping sickness.

I might go on endlessly and weary you with examples of chemical

reactions that play important roles in our knowledge of everyday medicine for chemistry enters into every manipulation of medicine and surgery. These will come to you naturally in the course of your studies. I merely wish today to show you a few of the instances in which the course in chemistry, which you are taking before you enter the Medical School, is as much a part of your everyday knowledge in the practice of medicine as is a knowledge of elementary anatomy.

SOME CHEMICAL PRODUCTS OF FLORIDA

WALTER H. BEISLER, UNIVERSITY OF FLORIDA, GAINSEVILLE, FLA.

Florida's most important industry is agriculture, which is quite natural on account of the moderate, sub-tropical climate, abundant rainfall, and good soil. About 3,000,000 acres are in cultivation, growing about 250 different crops comprising nuts, fruits and vegetables. Jacksonville and Tampa are the chief sea-ports and manufacturing centers of the state. A few of the chemical products of the state are tung oil, glass, rare minerals, Fuller's earth, kaolin, phosphate rock and wood products.

Phosphate Rock.—Florida mines about two-thirds of the phosphate rock produced in the United States. Well over 1,000,000 tons are mined annually with an estimated value of $10,000,000. While most of this material is shipped to northern and European markets, considerable quantities are converted to the mono-calcium salt (superphosphate) in Jacksonville by treating the rock with sulfuric acid.

A product known as non-acid phosphate is manufactured in this state by heating phosphate rock with a solution of K_2CO_3 and K_2SO_4, and then calcining the mass at 1200–1400° C. Twelve to fourteen per cent of the phosphate is converted to a form that is available for plant food, although the composition of the product is not very well known.

Wood Products.—It has been estimated that $50,000 worth of turpentine and rosin drips from the pine trees of the state each day of the summer. The trees are tapped by cutting through the bark with a special tool. The oleoresinous exudation is caught in pots of clay or galvanized iron. Most of this material is distilled in small, crude, copper stills, holding a charge of eight to ten barrels. Wood is used as fuel. The still is operated in such a manner that the turpentine is distilled, leaving the rosin behind. The latter substance is taken from the still by removing a plug. Both the turpentine and rosin are of very good quality. The turpentine obtained in this way is generally called gum turpentine to distinguish it from the product obtained by distillation of wood or by extraction by volatile solvents.

There is a wood distillation plant in Jacksonville. Rich pine is piled

on cars and pushed into large retorts, where the wood is destructively distilled until only charcoal remains. The volatile products condense in the form of an ugly, black liquid, which is worked up into wood alcohol, turpentine, pine oils, pine tar and pitch. The charcoal finds an extensive use in metallurgical operations and as an ingredient in poultry feeds. The pine oils are used largely for oil flotation processes in the copper industries of Alaska and Chili. Pine tar is used in the rubber industry. Two per cent of pine tar added to a second grade rubber improves its quality considerably. The pitch is used chiefly in calking ships. The turpentine has a slight yellow color and a rather unpleasant, smoky odor, but it is a very satisfactory solvent and paint ingredient. Large quantities of it are shipped to South America.

Tung Oil.—Tung oil is one of the best drying oils known. It is pressed from the nut of Chinese wood-oil tree, Aleuritis fordi, Hemsl. The nuts contain 33–43% of oil. The residue remaining after the pressing may be used as fertilizer.

Very crude methods are employed in China for obtaining the oil, where it has a host of uses, such as water-proofing and weather-proofing boats, homes, furniture, parasols, baskets, etc. In this country the oil is used in large quantities for manufacturing spar varnishes, oil-cloth and linoleum. Tung oil incorporated with ordinary rosin produces a varnish that will not turn white in presence of water. To prepare a good varnish with linseed oil requires the use of the more expensive and rare copal resins.

As the demand for tung oil grew, the Chinese soon learned the art of adulteration. Sesame, peanut and tea oils are said to be common adulterants. The difficulty of obtaining a satisfactory and adequate supply of the oil from China, led to attempts to grow the tree in this country. It was found that the tree thrived best on the grounds of the Experiment Station at the University of Florida. Within the past two years, thousands of trees have been set out in the vicinity of Gainesville, and it is expected that the industry will grow to tremendous dimensions.

The oil, when properly pressed, is a clear, light amber colored, viscous liquid. It consists almost wholly of the glycerides of oleic and elaeomargaric acids.

Glass.—The chief raw materials used in the glass industry are sand, lime and soda ash. Florida has tremendous quantities of the first two, and a plant in Jacksonville is now turning them into bottles at the rate of nearly 50,000 a day. The plant is equipped with a 45-ton continuous furnace, heated with Mexican crude oil, and two Lynch bottle-making machines, which operate with uncanny precision and speed. The finished bottles are packed in freight cars and shipped to Key West. Here the cars are run onto steamers and carried to Havana, Cuba.

Rare Minerals from Beach Sand.—Mineral City, just south of Pablo

Beach, looks more like a western mining camp than a section of the "playground of America." A mixture of rutile, monazite sand, zircon and ilmenite is separated from the beach sand by a long series of jig tables. The rare minerals are heavier than common sand, and when the beach sand and water are allowed to flow onto the jerky tables, the rare minerals simply walk away from the sand. The rare minerals are separated from one another by an ingenious system of electro-static and magnetic separators.

The monazite sand contains 5 per cent of thorium oxide, ThO_2, 33 per cent of cerium oxide, Ce_2O_3, and a trace of mesothorium, which is radioactive. Monazite sand is used in the manufacture of gas mantles, luminous paint and pyrophoric alloys, which are necessary for automatic cigar and gas lighters.

Rutile is TiO_2 and ilmenite is $FeTiO_3$. They are used in manufacturing titanium steel and pigments. During the war they were used in the manufacture of titanium tetrachloride, which was valuable for smoke screens and tracer shells.

Zircon, $ZrSiO_4$, was known only in gem collections a few years ago. It was valued chiefly for its color and luster, which rival those of the diamond. Zircon is now obtainable in Florida in car lots. It is highly prized as a refractory. Its melting point is 2550° C., and its fire shrinkage is exceedingly low. Its coefficient of expansion appears to be less than that of quartz. It is very inert to chemical action; boiling alkalies and acids do not attack it, and it is only slightly attacked by fused alkali. It is used in the manufacture of enameled iron ware, crucibles, muffles, retorts, fire brick, and porcelains for spark plugs, pyrometer tubes and filter plates. The hardness of zircon is 7.5 (diamond = 10), which indicates that it would make a good abrasive.

Fuller's Earth and Kaolin.—Florida produces about three-fourths of the United States production of Fuller's earth, which is a more or less impure and hydrated aluminum silicate. It has the property of absorbing grease and oil, and on that account it has been long used in cleansing woolen goods. Its chief use at present is in the bleaching and refining of oils, grease and lard.

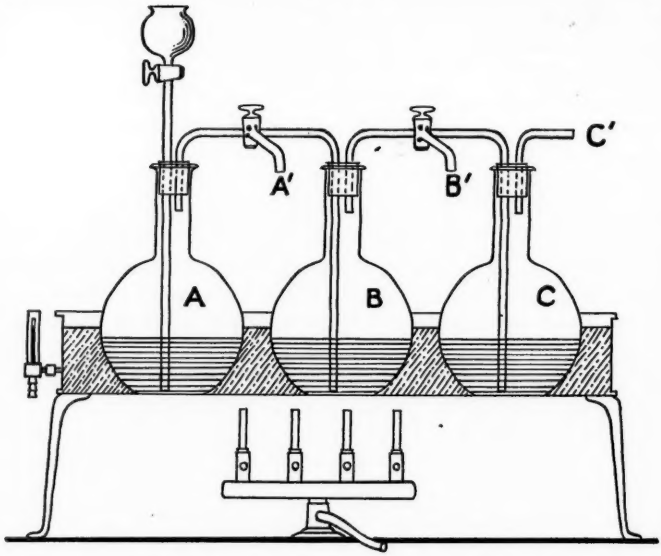
Kaolin or china clay is generally represented by the formula, $Al_2H_2(SiO_4)_2.H_2O$. It is a snow-white powder. Its chief use is in the manufacture of fine porcelain. Edgar, Florida, between Gainesville and Palatka, has a large deposit of kaolin, which is considered the finest in America.

DEMONSTRATION APPARATUS FOR THE SIMULTANEOUS PREPARATION OF THE HALOGENS

RAYMOND SZYMANOWITZ, NEWARK, N. J.

The apparatus herein described possesses great utility in presenting the subject of halogens.

A water-bath, three florence flasks, a thistle tube and two three-way stop-cocks are set up as illustrated. Flasks A, B and C are provided with fairly concentrated solutions of a chloride, bromide and iodide, respectively, with the weights of the salts employed in the ratio of the weight of



their molecules. The water-bath is kept at the boiling point throughout the experiment to maintain a constant and equal temperature.

Chlorine is liberated in flask A with the aid of manganese dioxide and sulphuric acid. By proper adjustment of the stop-cock, the gas may be collected at A'. To demonstrate its ability to replace bromine in compounds, the stop-cock is turned to permit the chlorine to enter flask B. The bromine, which in turn is liberated, may be sampled at B' either with or without the use of a condenser.

By permitting the bromine to pass into flask C, iodine is set free.

The apparatus enables the lecturer to demonstrate a common method for the preparation of the halogens, provides for the collection of specimens of all the halogens (except fluorine), and illustrates their replacement ability. Chlorine is shown in the gaseous phase, bromine in the liquid and

gaseous phases, while iodine, in the early stages of its liberation may be seen in solution with the undecomposed iodide, in the solid state and, in small quantities, as vapor. Upon continued heating, some of the iodine vapor deposits itself as a solid in tube C′ demonstrating sublimation.

By changing the order of the halides, it is possible to show the inability of the weaker halogens to replace the stronger members of the group. If the halogens are not collected at A′ and B′ and the same cation is present in each of the halides, the experiment may be carried out quantitatively to show, upon evaporation, that the original contents of flask A (as regards the halide only) have been formed in flask B, and likewise, the original contents of flask B formed in flask C. The iodine must be removed by filtration, of course, and any small quantities remaining in solution in C will be volatilized upon evaporation.

GROUP EXAMINATIONS IN CHEMISTRY

FRANK C. WHITMORE, NORTHWESTERN UNIVERSITY, EVANSTON, ILL.

All teachers recognize that examinations have certain advantages and certain disadvantages. Among the advantages are that they encourage or force the students to review their subjects and get a broad general view otherwise unobtainable; that they give the students a chance to check up on their mastery of the subject; and that they give the teacher an insight into his success or failure in imparting knowledge or in stimulating his students to acquire knowledge. Among the disadvantages are the generally recognized common lack of accurate coördination between a student's actual mastery of the subject and the results of the ordinary type of examination; the fact that the examination usually comes at the end of some period of learning and thus unearths weaknesses when it is too late to remedy them; and the fact that students usually cram for examinations and thus do not show what might be called their normal mental content in the subject.

At Northwestern University we have had the common experience of finding among our graduate students surprising weaknesses in various elementary studies. Subjects studied several years before have been forgotten, not merely as to detailed facts but also as to fundamental principles. In an effort to get mental cross sections of our group from time to time and thus unearth weaknesses in earlier or present training while there is still time to fortify such weaknesses there has been introduced a system of "Group Examinations." These examinations correspond to the new type of standardized test sometimes called "recognition tests." The novel feature in the present case is that the examinations are taken anonymously, so to speak. A large group of students is supplied with

copies of the current examination. Each one marks the answers to the best of his ability and drops his examination sheet in a box. *Neither his name nor any distinguishing mark appears on the paper.* The papers are looked over by the faculty to get a cross section of the current knowledge of the group on the subjects covered. Needless to say, the faculty gains much useful information in this way. When the students leave the room they usually gather in groups and argue about certain questions—a healthy sign. Later a copy of the examination is posted with the proper answers marked. There are many obvious advantages in this system and more are becoming apparent all the time. Among the less obvious ones is the possibility of asking questions which would be considered "unfair" in a regular examination. This makes it possible to check up on various extra-curricular chemical knowledge such as current chemical events, noted chemists and the like.

Part of a typical examination follows:

CHEMISTRY DEPARTMENT, GROUP TEST NO. 1

Underline proper words, symbols, etc.

1. *Red precipitate,* silver, lead, mercury, copper, chromium, cinnabar
2. *Oxygen is present in* sulfides, nitrides, chlorides, nitrates, hydrocarbons
3. *Most abundant element,* aluminum, calcium, chlorine, oxygen, sodium
5. *Oxygen unites directly with* Al, Ca, C, Cu, F_2, Au, He, H_2, Mg
6. *Oxygen discovered by* Scheele, Lavoisier, Cavendish, Priestley
11. *Liebig discovered or invented* bromine, sulfuric acid, "baby food"
12. *J. F. Norris,* Columbia, George Washington Univ., Harvard, M. I. T., Yale
13. *Hydrogen occurs* in Earth, Air, Fire, Water
17. *Reduction of nitric acid,* nitric oxide, ammonia, NO_2, nitrous oxide
18. *Zinc is more active than* Al, Ca, Cu, Au, Fe, Pb, Mg, Hg, Pt, K
20. *Reduction,* addition of oxygen, addition of hydrogen, addition of electrons, removal of electrons
22. *Atmospheric pressure* is measured by a eudiometer, barometer, psychrometer, manometer, cathetometer, catathermometer
31. *Water decomposed by* heat, light, electricity, alpha particles
34. *Carbon dioxide, more soluble than* H_2, N_2, O_2, SO_2, NH_3, HCl
40. *Inert gases,* argon, boron, columbium, erbium, helium, holmium, krypton, neon, niton, radon, rhodium, thulium, xenon
49. *Oxidizing agents,* hydrogen peroxide, dichromates, ferrous salts, nitric oxide
50. *Ionization,* carbohydrates, salts, alcohols, ketones, acids.

It will be seen at once that a proper choice of materials for the questions will make this type of Group Examination a valuable educational aid.

THE ART OF LECTURE TABLE DEMONSTRATING

H. F. DAVISON, BROWN UNIVERSITY, PROVIDENCE, R. I.

Chemistry is a study of matter and it can never be adequately learned from books. Students must see the material that is talked about and must eventually handle it themselves. But beginners have to be shown what chemicals will do and how they are best handled. This is the business of the teacher, who must be something of a demonstrator at the lecture table if he is to be successful in arousing the interest of his pupils. There can be nothing more stupid than a long winded attempt to tell how sulfuric acid is made, what its properties and its uses are, without showing the actual process of its manufacture and its chemical action by various experiments. One may just as well try to draw word pictures of beautiful paintings expecting that this can satisfy as well as the reality.

The eye is wonderfully quick to perceive what the brain cannot, at the moment, encompass, but the mental impression provoked by the eye will last for years, to be better understood in later days perhaps.

Much teaching of chemistry is for students who do not intend to continue it beyond one year and for these the only chance to become acquainted with much of what chemicals are and do is by watching the teacher as he puts the substances talked about, through their paces. It profits a man little to *tell* his fellow townsmen he has a fast horse, but it profits a teacher much if he *shows* his pupils what chemicals will do under proper guidance.

There are certain fundamental rules to follow in demonstrating. It goes without saying that the experiments must work. Nothing is more fatal to success in this line of work than any considerable percentage of failures. Far better is it to have no demonstration than to have "fizzles." It is easy to say that "the experiment worked last night" or that the "chemicals are old" or what not, but the moment you do say any such thing the confidence of the students has lessened. If, as sometimes does happen, some unforseen condition makes havoc with your demonstration, it is best to state what you believe is the trouble, promise to show the experiment properly at some future time, and do it. Confidence that you were able to do what you had promised will again possess the students and your position will be thereby much strengthened.

I have seen a demonstrator keep his spectators "on edge" for a long time, trying hard to make something "work," until both spectators and demonstrator were in a cold sweat, and out of this much labor nothing was born. It would be far better under these circumstances to stop than to try hard.

There can be no doubt that men who make good demonstrations before a class, must have a natural aptitude for handling apparatus and making it show results. The demonstrator must have a certain amount of manual

dexterity, which, while it may be acquired to a certain degree by long practice, is generally a "knack" which the man had before he thought of performing experiments before a class.

To be a good and original demonstrator requires that one should know how to work with materials. Soldering, glass working, cementing, drilling, cork boring and all the minor operations of the worker in laboratory materials should be as familiar as eating a meal.

An ability to "set up" apparatus is a prime requisite in a demonstration. A man who ties up loose joints between glass and rubber tubing with string will never make a first class demonstrator.

The secret of success before a class is in the preparation before the class comes in. It does no harm to the most seasoned veteran to run through his demonstrations before his class appears.

Experiments should be simple and speedy. Complicated apparatus is out of place before a class. The author once saw a complete water-gas plant operated before an audience. Three men attended it, and after about a half-hour succeeded in getting gas enough to light. Needless to say there is little educational value in that sort of experimentation. Any experiment which takes over five minutes will be of doubtful value. There is nothing more trying to students or teacher than to have to wait a considerable time for something to happen. Interest in the experiment lags and then is just the time that those students who like to make a joke of the course or of the teacher, attempt it. One should see to it that his experiments go quickly to a conclusion. Much of the author's time has been devoted to the speeding up of lecture-table demonstrations and to simplifying the apparatus.

To expedite work at the lecture table, all materials should be weighed by measure. Take an example. Suppose a given experiment requires 10 gr. of powdered sulphur. It is not doing the student any good to wait while you weigh this amount out on the balance. What you should do is to find some small beaker or dish which, level full, holds approximately the required 10 grams. This may be marked and put away with the rest of the apparatus for this experiment. Liquids should not be measured in graduates, generally, but a test tube known to hold the required amount when full, is used. Of course occasions arise where, as in titrating before a class, accuracy of measuring must be looked out for, but for the ordinary lecture demonstrations it is far better not to have to resort to graduates. It sometimes pays both in solids and liquids to have the right amounts weighed out or measured out before the class comes in.

Never should one attempt to set up apparatus after the lecture has begun. Have everything in readiness beforehand. Nothing is so disconcerting to students as to have the lecturer fumble around in the cupboards

under the lecture table for a ringstand or gauze which should have been ready when he started to lecture.

There is a tendency on the part of lecturers to forget that it is to the class the experiments are being shown, and not to those who are performing them. Experiments should be set out near the front edge of the table, and care should be taken that students who sit off at the sides of the room do not have their vision obstructed by other pieces of apparatus which may be on the bench.

The size of the apparatus which it is best to use has to be left to the judgment of the individual teacher and depends, of course, on the size of his lecture room. Some experiments do not admit of performance on a large scale. The author deplores very much the great increase in the size of lecture rooms in recent years, for in only a relatively small lecture room holding 260 students he finds it is difficult for the students in the rear of the room to see what is going on in front. In one very large lecture room in a University which he visited, the author was told that many of the students had to bring field glasses in order to see much of anything that was going on at the lecture table. There is a long span of educational history between Mark Hopkins, a log and a student, as the constituents of a college, and such a college that the professor and his students are at telescopic range, physically and probably out of range personally.

Much time in succeeding years can be gained by putting away the apparatus used for a given experiment on a shelf by itself, to remain together until called into use again. This, of course, entails the use of considerable "dead" stock because many pieces of apparatus have to be duplicated on the shelves. A modification of this plan might be used with profit. Such articles as iron ware, bottles, hydrometer jars and precipitating jars which are in common use, may be taken at each lecture from the common stock, but all special pieces like bent tubing, special sizes of jars, special apparatus ready set up should certainly be retained in some special place for future use.

All the apparatus stored should be thoroughly cleaned before storage and glass stoppers should be insured against sticking by inserting a piece of paper between the stopper and bottle neck. No chemicals that can decompose or deliquesce should be allowed to remain. The author once got into serious trouble by leaving soda lime used as a dryer for ammonia, in the drying column. The next year a cake had formed over the top, and, acting as a plug, nearly caused the bursting of the whole apparatus. A stopper fortunately blew out, indicating that trouble was imminent, but the class was subjected to a gas attack not at all pleasant.

No experiments should ever be shown *simply* because they are spectacular. Students soon become irked by these. Every experiment shown should have a definite purpose to show some chemical truth and that

truth should be forcibly brought home. There are plenty of spectacular experiments, to be sure, but their scientific import is to be emphasized rather than their value as entertainment. Even the simplest demonstration can sometimes be used to show a great truth and will become absorbingly interesting to inquisitive students.

In the writer's student days, a very complex demonstration of the chamber process of sulfuric acid manufacture was shown. But the cumbersome apparatus got more attention that the reactions going on. A very simple demonstration now used serves the purpose much better in the opinion of the writer, because the apparatus used has no attraction away from the process, and in five minutes can be shown all that required fifteen or twenty with the more complex apparatus.

One must never be too sure that students grasp the import of a lecture table experiment. After having shown a set of three perfectly lucid experiments to prove that hydrogen gets through small openings faster than air does, the writer gave a test and asked the question "How can it be shown that hydrogen goes through a small opening faster than air can get through?" The student whose answer follows was present when the demonstrations were made. The answer is here reproduced as nearly as possible like the original. "If you fill a glass bottle with hydrogen and put a piece of curved glass tubing in the mouth of bottle so that it runs from bottle in a curve to outside thus: (here is a diagram which has been crossed out and substituted by another which looks like an army revolver). Also allow no air to enter bottle—that is, thrust the curved tubing through a one-holed rubber bottle cork. Then it will be noticed (here I am referred by a long scrawled line terminating in an arrow head to the preceding page for a continuation of the discussion) that the hydrogen will go through the small opening which is inside the bottle must faster than air goes through the small opening of the tubing, on the outside of the bottle. Thus hydrogen is better for running mills than oxygen. For example, our factories run by water power." I defy even a professor of chemistry to fathom out what experiment that student saw.

In spite of this horrible example, I believe that most students get the point of a good demonstration and that the impression made by it lasts a life time.

It must be perfectly obvious that not every chemical reaction can be shown as a demonstration and the blackboard must be used for these. And it is equally obvious that the blackboard can supplement the demonstration and should be used freely. The most effective demonstrators try to cultivate the art of talking in connected sentences while performing the experiments. Perfection in this is hard to attain, especially when something "hangs fire." Nevertheless one may often cover the awkward situation by a free use of his mother tongue.

It is hard work to get up good demonstrations and unless one is willing to put at least as much time on the average in getting them ready, as he takes to show them, he will probably never be especially convincing to his students.

SOME SUGGESTED CHANGES IN HIGH-SCHOOL CHEMISTRY*

GEORGE MERVIN BROWNE, SOUTHERN ILLINOIS STATE NORMAL UNIVERSITY, CARBONDALE, ILLINOIS

The object of education is to prepare the child to live a useful happy life in the midst of his fellows and his natural environment. He can do this only by conforming to the laws established by his fellows and by his creator. Chemical processes are the foundation of his living, and only as he conforms to them can he be healthy, happy, or efficient in his living. Of the subjects in the high-school courses of study the following: agriculture, botany, physics, physiography, physiology, cooking and zoölogy are dependent on chemistry or applied chemistry. No one can any more understand or enjoy these subjects without an elementary knowledge of chemistry than he can without a knowledge of reading or arithmetic. A study of chemistry should therefore precede the study of the above-mentioned subjects. That is, chemistry should be a second and not a fourth year subject as in most high schools at the present time, and the other natural sciences should follow chemistry. *This is the first change that I suggest: That chemistry be moved to the second year of the high-school course of study.*

Since chemistry is the foundation of the other sciences, the topics selected for study should be those that contribute to the understanding of these sciences. Man's contact with the natural world demands knowledge of that same world, hence he must have knowledge of the chemistry of air, water, salts, acids, alkalies, and of the action of these upon one another and upon metals and other substances in common use. He should have a knowledge of the foods of both plants and animals and of the chemical changes that take place in these during their digestion, assimilation and the elimination of their waste products. He must also be familiar with the chemistry of growth, of death and of decay of plants and animals. He must also know the chemistry of fuels and combustion, the influence of light, heat, electricity, vibration, catalytics, and inhibitors on the chemical activity of all those elements and substances that enter into the experiences of everyday living. Of course some of the topics that are now studied in high-school chemistry must be omitted to make room for these. But many of them do not belong in high-school

* Read before the Southern Illinois State Teachers' Association.

chemistry and should be omitted. They were put into the texts to fill them up and are not needed nor do they belong in an elementary course in chemistry. They belong in more advanced courses, to college courses in chemistry. Why study Boyle's law? It belongs in quantitative chemistry and not in a beginner's course. The same is true of Charles' law. Why spend time on chemical arithmetic? Chemical calculations belong to quantitative chemistry, not to elementary, and quantitative chemistry does not belong in the high school. Why spend time over the distinction between physical and chemical changes? Few expert chemists make such a distinction. There are no chemical changes that are not accompanied by physical ones. Why spend time over the periodic law? If it were true, its importance is not great. Are atomic numbers of importance to the average citizen? Of what use is it to a farmer to know that uranium and thorium radiate helium and degenerate into isotopes of lead? Is it not much more valuable to know that compounds of lead are poisons and are to be used carefully for the protection of his fruits while growing, but must not be left around for his stock or for his children to eat?

When we consider that the average family spends more than 75 per cent of its income for food, fuel, shelter and clothing, it would seem that at least a fourth of his time in the chemistry class should be spent on the study of the compounds of carbon. Every graduate of the high school should be familiar with the chemical behavior of such common things as fats, oils, soap, glycerine, and of the numerous carbon acids like acetic, formic, oxalic, citric, malic, tartaric, benzoic, salicylic, etc., and of the carbohydrates, starch, cellulose, dextrin, and the various sugars. If every high school boy knew all about fermentation and its products he would never become a moonshiner or a moonshiner's customer. A chemical knowledge of organic nitrogen compounds would tend to prevent the formation of the drug habit and tend to reduce the death rate among our young men and women. We are trying to educate our boys and girls to become good citizens; and to be good citizens they must be useful citizens and enjoy themselves and each must do his share of the world's work. They get joy out of work only when they are healthy, and they cannot be healthy unless they conform to the laws of their environment as shown forth in the chemistry of that environment.

My second suggestion is: *That all quantitative topics and all theoretical topics be omitted and the time thus saved be devoted to the study of the more common carbon compounds.*

The colleges of the North Central Association have no set entrance requirements, hence there need be no special consideration given to those students in chemistry that intend to enter college.

My third suggestion is: *That no persons be graduated from high school without one year of chemistry.*

INTRODUCTION TO THE SYSTEMATIC TREATMENT OF FIRST YEAR CHEMISTRY

P. M. GLASOE, ST. OLAF COLLEGE, NORTHFIELD, MINN.

The approach to the subject is all important. Just as there are two ways of making an address, either to announce your subject at the beginning or else leave it to the audience to state it when you are through, so in teaching chemistry you may tell the class from the start just what chemistry is and what it explains, while the chances are that they will forget all about it before they leave the room; or you may go to work, not mentioning chemistry, and build such a foundation and superstructure that when you are through there is no doubt in the mind of any one of the students, what chemistry is, what it does and proposes to do.

Chemistry is not an unplatted jungle, full of pitfalls and sloughs of despair, inhabited by fierce hobgoblins and wild beasts waiting to devour you. Chemistry is a Garden of the Gods, full of commonplaces made realistic and startling through the intimate association of the known with the unknown. It is an Elfland where little sprites and spirits spring their surprises at every turn of the hand. In Elfland they would have no trouble explaining differences of color, solubility, boiling point, conductivity—they would simply assign a special gnome to look after each such little detail and all would be well. We, on the other hand, having banished spirits and trolls, are face to face with insoluble mysteries on every hand. It does no harm to invest the subject with a little air of mystery for at bottom all of it is mystery. For us to pretend that all is plain and straightforward is either conceit or deceit and students are not going to respect us for either if they ever get far enough to suspect how little we know about the cause of these mysteries.

The foundation of first year chemistry should be laid on what the pupils already know and not on a mass of new definitions and ideas couched in a vocabulary that is strange to them. Intelligent young people of today know a lot of things for which we are too often unwilling to give them credit. Every young person entering upon a course in chemistry already knows more or less about twelve to fifteen common metals and from four to six nonmetals. Why not bring this out at the start and tell them that the study of first year chemistry deals with these very substances and only four or five more?

They also know more or less about combustion, solution, pulverization, heating, melting, solidification (crystallization), conduction of electric current, vaporization, condensation, distillation, compression of gases, comparative weights of gases, solids and liquids, etc.

They know a number of substances which are in frequent use in first year chemistry, such as: sugar, salt, boric acid, epsom salt, hydrogen peroxide, vaseline, kerosene, gasolene, lubricating oils, milk, butter,

sour milk, lye, soda, wood, coal, water, vinegar, battery acid, tinner's acid, alcohol, chloroform, ether, camphor, dyes, etc. What we need to do is to organize their knowledge for them, to teach them the vocabulary of science and the accurate terminology for things they already know but for which they have been using incorrect words and expressions. The metals and nonmetals they already know lend themselves well to the development of the subject.

Since weight is the most universally appreciable property of matter we begin by discussing the meaning of weight; the relation of mass to weight; the variation of weight with geographic location, density, specific gravity, water as a standard of comparison, the weight of a cubic centimeter of water. Here the metric system of weights and measures must be thoroughly reviewed, so that we can talk scientifically about the materials and processes used.

Having introduced a list of all the metals and nonmetals they already know, we can now introduce the idea of atomic state. It is no strain on their imagination to attach a definite comparative weight to each one of these ultimate particles. They appreciate beforehand that all these substances have different weights, specific gravities. In this way we lead them to the conclusion of atomic weights. The conception atomic weight is all that is necessary to introduce the systematic arrangement of the elements for future study.

From the atomic weight table in the textbook let the class make out a list of the elements in the order of the atomic weights beginning with the lowest. We now have to make a little study of the elements as they come in order. If we can show samples of the different elements in turn it becomes very impressive. They find hydrogen and helium as the two lightest. Both of these may be new names to some but to a number both are known. We call attention to the fact that both are gaseous substances and therefore differ sharply from lithium which we find to be distinctly metallic and a solid. Glucinum is likewise metallic, and boron partakes of metallic properties, but when we come to carbon no first year student would fail to tell you at once that it is a nonmetal. Nitrogen and oxygen are known to them as constituents of the air while fluorine may never have been heard of before. If we prefer we may also add neon here. This series, from lithium to fluorine, cannot help but be impressive to any young person with a tendency to inquisitiveness.

If we can show them a sample of sodium it will come to them as a distinct sensation that in passing from neon, atomic weight 20, to sodium, atomic weight 23, we jump from a gaseous nonmetal to a typical metallic solid. This series has the decided advantage that every member of it is known to them, at least by name. Again we find that after sodium we have two more typical metals, magnesium and aluminum, followed by

silicon which also looks like a metal. The next member, phosphorus, is easily classified as a nonmetal, as are also sulfur and chlorine. Here again we have passed over into the gaseous state. This is then the result of our arrangement:

H He Li Be B C N O F Ne Na Mg Al Si P S Cl A

Leaving H and He out of consideration we have this interesting fact:

Three metals—five nonmetals—three metals—five nonmetals.

Some of the students are going to ask at this point whether we can go on and find the same sort of sequence. We can point out that we again jump from the gaseous nonmetal argon to the solid metallic potassium, which in turn is followed by other typical metals. The elements so far given cover about two-thirds of the year's study and the future will open up the further arrangement.

We have already noted the repetition of three metals and five nonmetals. Rearranging the first sixteen elements beginning with lithium, so that the metals come under each other, we get:

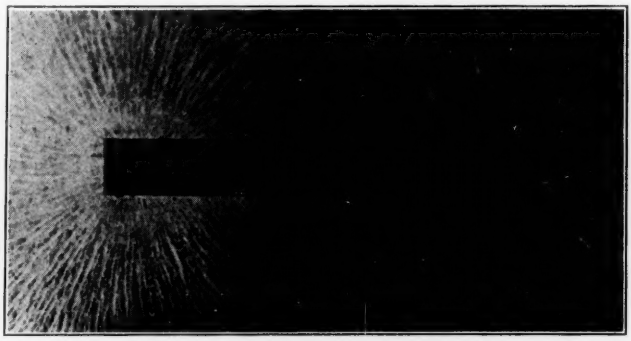
Groups	I	II	III	IV	V	VI	VII	O
Series 1	Li	Be	B	C	N	O	F	Ne
	7	9	11	12	14	16	19	20
Series 2	Na	Mg	Al	Si	P	S	Cl	A
	23	24	27	28	31	32	35.5	40

From now on we shall speak of the horizontal lines as series and the vertical columns as groups. It is already noticeable that in this scheme the metals fall at the left and the nonmetals on the right. The interest will be decidedly enhanced by calling attention to the fact that the elements occurring in the same group are similar in character. Thus Li and Na are very much alike, so are Be and Mg, B and Al, etc., until you reach F and Cl which behave with great similarity.

It is a fact easily demonstrated that the elements at the extremes of these series have a great affinity for each other. Thus sodium unites energetically with chlorine, giving a substance we call sodium chloride; sodium unites also with sulfur to form sodium sulfide. In fact any one of the metals will unite with any one of the nonmetals to form combinations or compounds. All of these compounds being made up of two elements are called binaries and all have their names ending in -ide.

If a compound such as sodium chloride be dissolved in water and the two poles of a battery dipped in the solution the chlorine is given off at the positive pole and the sodium is drawn towards the negative pole. Based on the law of electrostatic charges, that likes repel and unlikes attract, we reason that sodium is positive and chlorine negative. In like manner it is found that all the elements of the first three groups are posi-

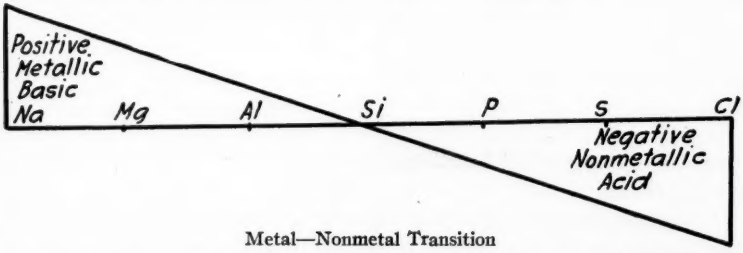
tive and those of groups V, VI and VII are negative. It follows as a natural conclusion that the members of group IV are neutral. This variation of properties may be nicely illustrated by the following photograph of a magnet:



Positive—Neutral—Negative Transition

By means of the graph below we may now represent the positive and negative characteristics of the elements of the two series, also the metallic and nonmetallic properties. This helps to fasten in mind the identity of positive and metallic, negative and nonmetallic. If it does not *explain* chemical affinity; it does furnish a very helpful cue to the scope of this affinity and, to some extent, the magnitude of it as well as a reasonable explanation of the stability of compounds.

In connection with this treatment we can now introduce consideration of acid and basic properties. There is no difficulty in affiliating basic with positive and metallic and acid with negative and nonmetallic. All these properties may be represented on one and the same graph.



Metal—Nonmetal Transition

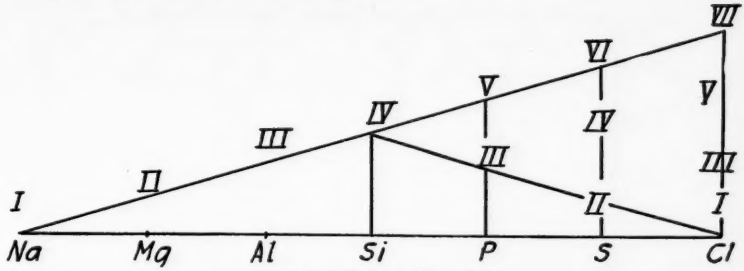
So far we have said nothing about valence. If symbols have been used at all it is in designating the members of the first two series. All the combinations that can be made may be represented without the use of subscripts simply to designate affinity, stability and the formation of bi-

naries. We may now begin to teach valence by showing that sodium combines with one chlorine, $NaCl$, magnesium combines with two chlorines, $MgCl_2$, aluminum combines with three, $AlCl_3$, silicon with four, $SiCl_4$. Likewise chlorine combines with one hydrogen, HCl, sulphur combines with two, H_2S, phosphorus with three, PH_3, and silicon with four, SiH_4.

By introducing the oxides we may teach the variable valence of the non-metals as follows:

Silicon forms SiO_2
Phosphorus forms P_2O_5 and P_2O_3
Sulfur forms SO_3, SO_2, SH_2
Chlorine forms Cl_2O, Cl_2O_3, Cl_2O_5, Cl_2O_7

All this must be done with structural formulas, impressing that oxygen has the valence of two only. The variations of valence in the two series studied may be represented as follows:

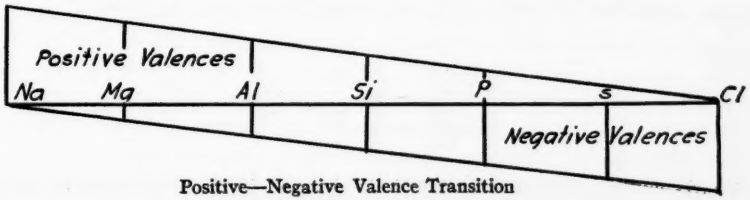


Numerical Valence Transition

So far no mention has been made of any difference between positive and negative valence although any student will be able to tell you that since hydrogen is positive and has a valence of one, chlorine must have a negative valence of one to unite with hydrogen to form HCl. By using the oxides of the second series, thus:

						Cl_2O
Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3	SO_2	Cl_2O_3
				P_2O_5	SO_3	Cl_2O_5
						Cl_2O_7

it is possible to show that positive valence persists clear across the series. That negative valence persists to the left beyond group IV may also be demonstrated. On this broader basis we may then indicate the variations of positive and negative valence by a scheme such as this:



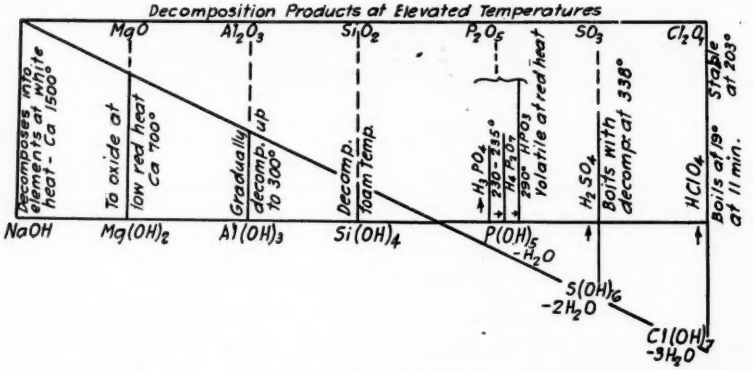
Positive—Negative Valence Transition

While the objection may be raised to all these graphs that they are not quantitatively accurate the fact remains that they do stand for average conditions and show at least that there is variation and that that variation is more or less regular.

Another group of compounds, from this same series of elements, which proves most useful because of the generalization it may be made to teach, is that of the hydroxides. They may be arranged as follows:

$NaOH$	$Mg(OH)_2$	$Al(OH)_3$	$Si(OH)_4$	$P(OH)_3$	$S(OH)_2(?)$	$Cl(OH)$
				$P(OH)_5$	$S(OH)_4$	$Cl(OH)_3$
					$S(OH)_6$	$Cl(OH)_5$
						$Cl(OH)_6$

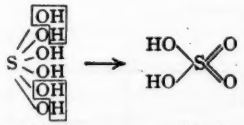
The stability of these hydroxides may be emphasized by means of a graph.



Hydroxide Stability Transition

From this treatment it is manifest that both bases and acids have hydroxyl groups. By taking the highest theoretical hydroxide of sulfur and writing it structurally we have:

then if, as shown on the graph, we remove two molecules of water, thus:

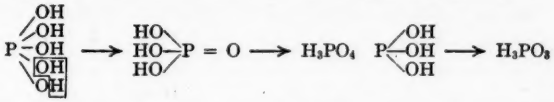


we get sulfuric acid and demonstrate that it has two hydroxyl groups.

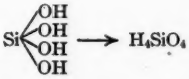
In like manner we show that the acids of chlorine have one hydroxyl apiece:

ClOH	$Cl(OH)_3$	$Cl(OH)_5$	$Cl(OH)_7$
	$-H_2O$	$-2H_2O$	$-3H_2O$
HClO	$HClO_2$	$HClO_3$	$HClO_4$

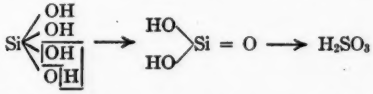
Again, from the hydroxides of phosphorus we demonstrate that phosphoric and phosphorous acid each has three hydroxyl groups:



Normal silicic acid is the theoretical hydroxide of silicon and therefore has the formula:



By loss of one molecule of water we get orthosilicic acid thus:



When, later on in the year, we arrive at the study of phosphorus or chlorine and the student has forgotten how to derive the structural formulas of the acids, the whole thing may be recalled by reminding them that to get the acids we must subtract three molecules of water from the group VII hydroxide, two from the group VI, one from the group V, and none at all from the group IV hydroxide.

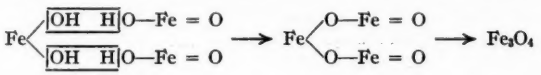
If the empirical formula be known the student will have no difficulty deriving the structural formula when he remembers that the hydrogens are always attached to oxygen and the hydroxyl groups thus formed connected with the nonmetal. After a little practice the structure of such acids as pyrosulfuric, pyrophosphoric, chromic and dichromic acids is easily worked out.

It now becomes clear that there must be some other fundamental difference between bases and acids than that bases are hydroxides. To be sure we may say that bases are hydroxides of metals and acids are hydroxides of nonmetals. The real difference between them appears in ionization where acids give hydrogen ions while bases give hydroxyl ions.

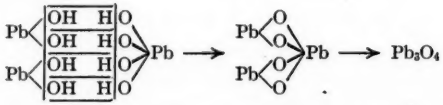
From this we conclude that an amphoteric hydroxide is one that can, as occasion demands it, give off either hydrogen or hydroxyl ions. In the second series aluminum hydroxide is the only one that shows this dual property. From a broader consideration, however, it is more accurate to say that every element is more or less amphoteric. In the series of hydroxides we have shown, every element is positive, chlorine showing

positive valences of 1, 3, 5, 7. The nonmetals show negative valence towards hydrogen, but it is manifestly erroneous to ascribe the acid forming property of nonmetals to the fact that they are negative in electrolysis.

The most useful generalization of first year chemistry is the teaching about acids and bases and the effect of acids on bases. Once it is thoroughly understood it serves as a skeleton for the whole year's work and all that has to be done is to fill in the general and special considerations. What else are all binaries than salts of binary acids? Yes, we may even look upon water as possessing the characteristics of both base and acid as it yields both hydrogen and hydroxyl ions. The oxides of the metals are nothing else than the anhydrides of bases, while the nonmetallic oxides are anhydrides of the acids. Acids react on bases to form salts and water; likewise a metallic oxide unites with a nonmetallic oxide to form a salt. Some authorities go so far as to explain such compounds as Fe_3O_4 and Pb_3O_4 as combinations of basic and acid oxides. Thus Fe_3O_4 would be a salt of the basic hydroxide $Fe(OH)_2$ united with the ferric acid $HFeO_2$, thus:



and Pb_3O_4 would be a salt of the basic $Pb(OH)_2$ having been united with the acid H_4PbO_4, thus:



By this explanation Fe_3O_4 is ferrous ferrate while Pb_3O_4 is plumbous plumbate.

You deal with acids in every chapter of a first year text. Salts you meet on every page. Therefore this generalization should come early. What conception can the class have of the substance $KClO_3$ when oxygen is to be prepared unless they know something about the element chlorine and its acid chloric acid and that this acid reacting with KOH gives $KClO_3$? How much more interesting the chapter on the atmosphere becomes when they understand something about the nature of nitrites and nitrates, about nitric acid being made from air by means of the Birkeland-Eyde process. How impossible it is without the conception of acid and base to teach that chlorine water changes to HCl and HClO; that this mixture neutralized with sodium carbonate is Javelle water. How easily they can grasp the chemistry of Dakin's solution when they understand that bleaching powder is a salt, which with water hydrolyzes to HCl and HClO, the latter of which is the antiseptic and disinfectant because it easily gives up its oxygen in nascent form.

BENJAMIN HALE—PROFESSOR OF CHEMISTRY AND COLLEGE PRESIDENT*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASS.

A professor of chemistry frequently becomes a college president. Benjamin Hale belongs to this class. He was the Professor of Chemistry in Dartmouth College from 1827 to 1835 and President of Geneva (afterwards Hobart) College, Geneva, N. Y., from 1837 till his death in 1863.

It is not my purpose in the present paper to give a detailed account of Benjamin Hale's scientific work nor of his career as an administrator. One incident in his experience as a teacher of chemistry is significant, picturesque and pathetic. This incident is the one to which this paper is devoted.

Benjamin Hale was born in 1797. He entered Bowdoin College in 1814 and graduated in 1818. Here he studied chemistry and mineralogy under Professor Parker Cleaveland, acquiring not only a knowledge of these sciences but also a deep love for science and a high regard for the scientific method of studying, thinking and teaching. Coupled with his love for science was a profound interest in religion. After a very short period of teaching, he entered Andover Theological Seminary, graduated, and began preaching in 1822. The next year he was a tutor in Bowdoin College. In 1822 he was appointed Principal of the Gardner (Me.) Lyceum. Here he remained until 1827 when he was elected Professor of Chemistry and Mineralogy at Dartmouth College. He succeeded Professor James Freeman Dana. In Professor Dana's time seniors were allowed to attend lectures in chemistry and anatomy on payments of $4.00 a year, and juniors $2.00. In Professor Hale's early years seniors and juniors were allowed to attend the fourteen or fifteen weeks of his daily lectures delivered to medical students. Subsequently he held five or six weeks of daily recitations with the junior class. He also gave a separate course of thirty lectures in chemistry each year to undergraduates. In addition to these courses, he gave a course of twenty lectures in geology and mineralogy and collected about 2500 minerals, thereby starting the cabinet in this department.

There is no evidence that Professor Hale failed to do his teaching acceptably. But he was uneasy—scientifically and religiously. He was educated in a Congregational seminary and was teaching in a Congregational College. Nevertheless, he openly expressed the faith, teaching and service of the Protestant Episcopal Church. He lost his position by a drastic act, *viz.*, the abolition of his professorship by the Trustees in 1835.

So far, this account has lacked color. We now come to the justification

* Read at the Ithaca Meeting of the American Chemical Society, Sept. 10, 1924.

of this account and probably the real cause for Benjamin Hale's departure from Dartmouth College.

He wrote a letter to the Board of Trustees, a valedictory letter he called it, though "maledictory" would be a more fitting, if allowable, term. Among other things he says:

"It is a remarkable fact that there is not one member of your board whose pursuits in life lead him to any acquaintance with physical studies, and I presume the importance, absolute and relative of such studies is viewed by you as it stood in American colleges from thirty to fifty years ago when you were undergraduates, and your college feels the effect of this deficiency. It has not taken a scientific periodical, as far as I know, for half a century. The few that have crept into your library you owe to the charity of a pamphlet society which, through the influence of the late Professor Dana, among its other periodicals took one *Quarterly Journal of Science;* and at its decease bequeathed its collection to your library. Since its death, no report of the progress of science finds its way within your walls, save the *Journal* of Professor Silliman, taken by the two respectable societies among the students.....A few years ago, no provision was made for chemical lectures to college classes, and members of higher classes were in the habit of making a contract annually with Professor Dana for the privileges of attending his lectures."

Soon after leaving Dartmouth College, Benjamin Hale took orders in the Episcopal Church. When he was elected President of Geneva (afterwards Hobart College) in 1837, the spirit of revolt against the old regime was still strong, for in the next year he published two pamphlets entitled "Liberty and Law" and "Education in Its Relation to Free Government."

Some one else must write the story of President Hale's career as an administrator. My purpose has been to reveal an incident in the early experience of a man, who, had he continued to be a chemist would have achieved renown as an investigator at a time when chemistry sorely needed such men.

The Trustees reëstablished the chair of chemistry in 1836—the year after Benjamin Hale's forced departure. Prof. Oliver P. Hubbard, son-in-law of Benjamin Silliman, was appointed the successor of Benjamin Hale, and as a sort of retribution the Trustees saw him remain at Dartmouth College about forty-seven years doing and demanding in larger measure the very things that stirred Benjamin Hale to revolt and ultimately terminated his career as a chemist.

USES OF ETHYLENE*

F. B. Arentz, U. S. Industrial Alcohol Company, Baltimore, Md.

One hundred and thirty years ago four Dutch chemists obtained a new gas by heating alcohol with sulfuric acid. They called it "Olefiant Gas" because of the oily like nature of its compounds. The gas itself which contained both hydrogen and carbon was very different from the then only other known hydrocarbon, marsh gas. Because of their different specific gravities they were termed light and heavy carburetted hydrogen, respectively.

For a hundred and twenty years ethylene as we know it continued to be one of the chemist's playthings, he worked out its properties both chemical and physical, he studied a great many of its reactions and chemical combinations but he failed to find a place for this gas with its admitted useful properties.

It remained for the World War with its ever increasing demands on the chemist to give ethylene a real start in life. Dichlorodiethyl sulfide or "mustard gas" was one of the first of the poison gases used and ethylene was needed to make it. A plant was built at Edgewood Arsenal and production started, but as this was only a step in the manufacture of "mustard gas" very little mention was made of the process.

When the war closed, and with it the demand for mustard gas, it was only natural that the chemist should try to find other uses for ethylene. It was felt that if this gas was made available somebody either by chance or desire would find a use for it. Fortunately about this time the possibility of using ethylene in place of acetylene in cutting and welding was suggested. Tests were made which indicated that there was a promising field for this gas.

This, then in brief is the history of ethylene development and now what are some of the properties of this gas, how is it made, stored and shipped, and what are its principal uses?

With the formula C_2H_4 ethylene takes its place among the unsaturated hydrocarbons with their characteristic chemical properties. Its most interesting physical properties are, specific gravity of 0.98, critical temperature 9° C., and critical pressure 900 lbs. It is colorless and the pure gas is odorless, notwithstanding statements to the contrary.

The explosive limits are from 4 to 15 parts of ethylene to 100 parts of air which is a considerably narrower range than acetylene, hydrogen or carbon monoxide.

Another interesting property is the compressibility of ethylene and is best illustrated by the fact that a cylinder which will hold 100 cu. ft. of oxygen at 70° F. and 1800 lbs. pressure will hold 225 cu. ft. of ethylene at 70° F. and 1400 lbs. pressure.

* Read at the Baltimore Meeting of the American Chemical Society, April 10, 1925.

Ethylene is manufactured by dehydration of ethyl alcohol. This is best accomplished by passing alcohol vapor over a catalyst. The water formed is condensed out and the gas after suitable scrubbing and purifying is compressed into cylinders holding from two to twenty-five pounds.

We have found that there is absolutely no danger in compressing ethylene up to any reasonable pressure and that the only precautions necessary are the same as used for other compressed inflammable gases such as hydrogen. This means therefore that ethylene can be stored and transported like any other well behaved gas.

The use of ethylene for cutting and welding though it finds its principal use in cutting has increased steadily each year. Some of the reasons for the surprising growth of this gas in the cutting field are: greater safety, more convenient size and lighter weight cylinders and lower consumption of oxygen.

In the chemical field ethylene offers a wide range of interesting possibilities. Its ready combination with the halogens makes the production of ethylene dichloride, a valuable solvent for oils and waxes, comparatively simple. The use of ethylene bromide together with lead tetra ethyl has helped materially in the success of ethyl gas.

Other interesting possibilities are its use in the preparation of diethyl sulfate, ethyl chloride, liquid hydrocarbons, oxalic, propionic and tartaric acids and ethylene glycol.

One of the more recent uses for ethylene is in the coloring of oranges and lemons. Citrus fruits are mature and palatable while still green in color; in fact, some weeks before the skin attains the characteristic yellow color. If allowed to remain on the trees until the full color develops the fruit is frequently characterized by low acidity and high sugar content which gives it an insipid taste. In order to avoid this condition and the possibility of early frosts in some sections much of the fruit is harvested before it becomes yellow.

Various methods and experiments to artificially hasten the coloring of the picked fruit have been used and tried over a period of years by the citrus fruit growers. Until two years ago the best schemes developed consisted of placing the fruit in a suitable storage room and subjecting it to the fumes of gasoline engines or kerosene stoves. This method often imparted a disagreeable odor and taste to the fruit and was also very hazardous.

It remained for Dr. F. E. Denny and Mr. E. M. Chase of the United States Department of Agriculture, Bureau of Chemistry, after several years' work on the problem to discover that it was the small traces of ethylene present in the exhaust gases which was the active principal in the coloring process. Large scale coloring was then tried and it was found that using one part of ethylene in 3000 parts of air, a carload of oranges could be colored in five days with a total of only 25 cu. ft. of gas.

Some difference of opinion seems to exist as to what actually happens but the most generally accepted one is that the ethylene reëstablishes and speeds up the life processes in the cells of the fruit skin causing the color to develop very rapidly.

Today ethylene is being used by the citrus fruit growers all over California, in Florida, in Porto Rico and even inquiries come from Japan (which has a large citrus industry).

The latest and probably the most important discovery for the use of ethylene is in the field of medicine as an anaesthetic. The story of its development for this purpose reads like a fairy tale.

It seems that back in 1908 several shipments of carnations received by a Chicago florist immediately closed their petals and "went to sleep" never to reopen again. As this was a very unusual happening the florist who must have been more wide awake than most of the storekeepers chemists know, called in Dr. Crocker, a botanist in the University of Chicago.

Investigation by Dr. Crocker at the greenhouses located a leak in the illuminating gas pipes, and experiments in his laboratory in which he exposed carnations to the fumes of gas caused them to act exactly as did those received by the florist. He told them to stop the leaks in their gas lines and was then free to make some further investigation to satisfy his own curiosity which had been aroused. As ordinary illuminating gas is a mixture, Dr. Crocker proceeded to try its various constituents one at a time. He first tried carbon monoxide but without effect. Ethylene was then tried and immediately the flowers closed up for good.

Professor Arno Luckhardt also of the University of Chicago on hearing the experiences of Dr. Crocker decided that ethylene must be a deadly poison and determined to try it on animals. Lack of opportunity, however, delayed the work until 1922, when, with the aid of Mr. J. L. Carter an effort was made to settle the question.

Frogs were subjected to small traces of the gas with no apparent effect, then rats were tried with the same result. The concentration was increased a little at a time until it reached eighty per cent. At this point the rats acted queerly and finally curled up and went to sleep. Dr. Luckhardt thinking his rats were dead took them out from under the bell jar and to his surprise found them breathing but limp. After a few minutes the rats came to life again but on further subjection to high percentages of gas, they acted as before. From then on the work progressed rapidly and experiments with higher animals proved that ethylene was not a deadly poison but a real anaesthetic.

The last real test was still to be made, however. How would it act on human beings? Carter took the first chance and then Luckhardt, and lived to tell the tale. Others were then put to sleep with the new anaesthetic and were pinched and punched with pins without feeling it. Of

course the physiological effects were studied at the same time and fortunately were found to conform very closely to the requirements of the perfect anaesthetic.

Finally in March, 1923, actual operations were performed under the new gas with perfect results. From then on its use by surgeons all over the country increased by leaps and bounds, nearly a million cubic feet being used in 1924. Naturally the gas used for anaesthesia must be of the highest purity.

Here then is the real place of the simple chemical ethylene often made in the laboratory and occurring naturally in many places, now made to serve us in our industries, in our food and in our hospitals.

CHEMICAL SPELLING STIMULATES INTEREST IN CHEMISTRY

C. A. JACOBSON, WEST VIRGINIA UNIVERSITY, MORGANTOWN, W. VA.

Chemical spelling is now in its fourth year at the West Virginia University, and can therefore be considered past the experimental stage. By chemical spelling is meant the pronouncing of the names of chemical compounds by one person and the spelling of their formulas by another. The practice is especially suited to classes or groups of students who have finished or nearly finished their courses in chemistry.

At some convenient time the instructor will call the students together and place them in a row and begin the spelling by pronouncing a word like sulfuric acid or benzene, whose formulas, H_2SO_4 or C_6H_6 would be given by the first in line, and so on until every contestant had been given a word.

After the eligible contestants have been selected from preliminary spelling contests, they are assembled in an auditorium or suitable hall and given numbers which are pinned on, and visible from any part of the room. Some disinterested chemist is engaged to pronounce the words, while at least three persons keep the score.

Suppose 30 contestants have been chosen from the preliminary matches, and that these are arranged in a row on the platform. When a contestant fails to spell correctly the required formula the first time, another word is given to the next in line, and so on till the end of the row is reached. If six contestants fail to spell their words, the score keepers will give each of them the score of 30, after which they take their seats. The remaining 24 students will each have another trial, and if 4 students go down this time, these will get a score of 24. Let us assume that 3 are spelled down the third round, their score would be 20, and so on until one remains who will get the score of 1.

The 30 contestants are again assembled on the platform for a second

match, and the spelling continued as before. When three or more such matches have been completed, the scores for each contestant are added up, and the one having the lowest is declared the winner.

Experience has taught us that some form of reward or prize to the winner is necessary to arouse and maintain interest in chemical spelling. In last year's contest, held at the West Virginia University, the winner was awarded a set of books on chemistry. The next four highest in rank, including the winner of the first prize, received "Roll of Honor" certificates bearing the names of these five contestants together with the seal of the University, one copy being retained and framed for the Department of Chemistry.

A certificate, from each of the three annual contests held here, is hung in the chemistry building. The students, whose names appear on these certificates, are justly proud of their achievement for between three and four hundred chemistry students entered the spelling matches each year. These certificates, prominently displayed, serve as no small incentive for the members of the present freshman class to excel, not only in chemical spelling, but in their other work in chemistry.

The chemical formula of a substance may be considered the nucleus around which we assemble our information about it. Our knowledge will of necessity be limited when it comes to a large number of compounds, and since this is so, it is better to remember the formula of a substance than any other fact or condition about it, requiring an equal effort. The student who knows the formula of a compound certainly has the advantage over the one who does not.

Many students have expressed themselves as having been benefitted by the chemical spelling contests, and the effort they put forth to make a respectable showing. Without these contests they never would have acquired so large a chemical vocabulary.

Intercollegiate chemical spelling contests have been tried in at least one section of the country, namely the southwestern, and when this form of chemical education coupled with chemical amusement gains in popularity we shall hear of intercollegiate spelling contests from other localities.

Those who have never tried chemical spelling should do so, and experience the old time competitive spirit of the spelling bee, that will enliven the subject of chemistry, which to most freshmen students is so uninteresting.

A CLASSIFICATION OF THE ELEMENTS WITH RESPECT TO THEIR PROPERTIES

H. A. GEAUQUE, LOMBARD COLLEGE, GALESBURG, ILLINOIS

The classifications of the elements showing a large number of the relationships of their properties has resulted in arrangements so complex that their usefulness has been impaired. Their value, as an aid to the student in visualizing the relationship of the elements, has been decreased by the large mass of data contained or by the complexity of the design.

An examination of the relationships of the common properties of the elements compared to their atomic weights shows a similarity of the periodicity of the atomic weight relationship.[1] The changes in the properties, while apparently not of the same order, are expressed in variations similar or opposite to each other. Taking this assumption as the basis of classification of the elements and expressing the increase of the atomic weights periodically, a classification can be arranged as shown in the accompanying table.

An examination of this table shows that a number of the properties of the elements can be stated in two classes. The first, Class A, contains properties whose numerical value increases, in general, from Group I to Group VIII and from Period I to Period IX. The second, Class B, contains those properties whose numerical evaluations vary inversely to those of Class A. The suggested classification of the properties is as follows:

Class A	Class B
Densities	Specific Heats
Absolute Melting Points	Atomic Volumes
Absolute Boiling Points	Coefficients of Expansion

These properties might be designated as:

Class A ⇔ Intensity Properties
Class B ⇔ Quantity Properties

The magnetic properties of the elements are also shown in that the elements in the first half of the periods are, in general, paramagnetic and those in the last half diamagnetic.

This classification provides places for Cu, Ag, Au, Zn, Cd and Hg near the metals of Group VIII, a position which is indicated by the relationship of their properties. A comparison of the complex salts of these elements shows their relationship clearly. Especially interesting are the ammonia complexes of these salts, as a partial separation of the hydroxides of these metals can be made on the basis of the equilibrium of their hydroxides with ammonium hydroxide.

In Group I are two families of elements which are very much unlike in

THE CLASSIFICATION OF THE ELEMENTS ACCORDING TO THE PERIODIC LAW*

	Group 0	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Period I		1′ H 1.008							
Period II	2 He 4.00	3 Li 6.94	4 Gl 9.02	5 B 10.82	6 C 12.00				
		9 F 19.00	8 O 16.00	7 N 14.07					
Period III	10 Ne 20.2	11 Na 23.00	12 Mg 24.32	13 Al 26.96	14 Si 28.06				
		17 Cl 35.46	16 S 32.06	15 P 31.02					
Period IV	18 A 39.91	19 K 39.10	20 Ca 40.07	21 Sc 45.10	22 Ti 47.90	23 V 50.96	24 Cr 52.01	25 Mn 54.93	26 Fe 55.84 27 Co 58.97 28 Ni 58.69
		35 Br 79.92	34 Se 79.20	33 As 74.96	32 Ge 72.38	31 Ga 69.72	30 Zn 65.38	29 Cu 63.57	
Period V	36 Kr 82.90	37 Rb 85.44	38 Sr 87.62	39 Yt 89.00	40 Zr 91.00	41 Cb 93.10	42 Mo 96.0	(43)	44 Ru 101.7 45 Rh 102.91 46 Pd 106.7
		53 I 126.93	52 Te 127.50	51 Sb 121.77	50 Sn 118.70	49 In 114.8	48 Cd 112.41	47 Ag 107.88	
Period VI	54 Xe 130.20	55 Cs 132.81	56 Ba 137.37	57 La 138.91	58 Ce 140.25				
		(61)	60 Nd 144.27	59 Pr 140.92					
Period VII		62 Sn 150.43	63 Eu 152.00	64 Gd 157.26	65 Tb 159.20				
		68 Er 167.70	67 Ho 163.40	66 Dy 162.52					
Period VIII		69 Tm 169.4	70 Yb 173.6	71 Lu 175.	72 Ct	73 Ta 181.5	74 W 184.0	(75)	76 Os 190.8 77 Ir 193.1 78 Pt 195.23
		(85)	84 Po 210.	83 Bi 209	82 Pb 207.2	81 Tl 204.4	80 Hg 200.61	79 Au 197.2	
Period IX	86 Nt 222.	(87)	88 Ra 225.95	89 Ac 227.2	90 Th 232.15	91 Bv	92 U 238.17		

* Copyrighted 1925 by Laboratory Service, Inc.

NOTE: The numbers in front of the symbols are the Atomic Numbers.

properties. They are, however, the most active in their respective periods and from a valence consideration do not make the classification more complicated by being in the same group. The apparent differences of the two families in the other groups diminish. In fact, the relationship of the properties of the elements in Group VIII is very much closer between the elements in the period than any of the other elements in the group.

In conclusion, the advantages of the suggested classification are:

1. The Periodic Law is shown clearly
2. The emphasis is placed upon the correlation of the properties rather than upon the order of the atomic weights
3. The common properties are classified
4. The properties whose relationships are shown by a simple table are increased in number
5. The periods shown in the table are based on experimental data.

SUGGESTIONS TO THE TEACHER OF CHEMISTRY ON POISONS AND THEIR TREATMENT

R. G. TURNER, WEST VIRGINIA UNIVERSITY, MORGANTOWN, W. VA.

"Poison"—the word no doubt brings to the student's mind the picture of a small bottle across which is pasted a red label with skull and crossbones. How little does he realize the composition of the substance, or the physiological action it might render upon the body, except, probably, that to partake of the same would mean instant death.

To the teacher of chemistry, or at least to my mind and, I presume, to most all, the word brings forth formulas such as $HgCl_2$, KCN or As. These indeed are poisons but they alone do not complete the meaning of the word. The scope of the word covers a large field of chemistry, including organic and inorganic compounds, volatile and non-volatile, most of which are known to have definite chemical formulas.

To safeguard against the loss of human life it is the duty of every chemist to bear in mind the various substances called poisons, to know how poisons differ from foods, and to know the field of chemistry which the word itself involves. This knowledge will enable him to meet emergencies and prevent disasters that might otherwise occur.

For the benefit and aid of the teachers of chemistry my purpose is to bring these powerful and hazardous substances to their attention, to define and distinguish them from foods, and to give as briefly as possible a table containing suggestions for the proper treatment of those forms of poisoning most likely to occur.

A poison may be defined as any substance, not a food, which, acting di-

rectly through its inherent chemical properties, is capable of destroying life, or of seriously endangering health, either when it is applied to the body externally or when it is taken internally. The science of poisoning is known as toxicology. It is known that too much of one kind of food or too little of another may impair health and even at times be fatal. How, then, are we going to make a distinction between foods and poisons? It has been said that substances which set free or contain available potential energy are foods. Poisons such as aconitine, morphine, or strychnine as a rule display energy; witness the convulsive effects of strychnine, the coma produced by morphine, the cardiac depression caused by aconitine. This definition for foods then must be disregarded since it would include some poisons as foods. The one characteristic that makes a food a food is its power to repair waste, or to contribute a substance or substances, which are necessary for the growth of the body. They may or may not bring free energy into the body, but they all repair waste and provide the raw materials for life and growth. All substances which lack this power, although they may contain available energy, are not foods. Poisons, then, are not foods, since they do not supply materials necessary for growth or the nourishment of living matter. Poisons are sometimes used to benefit living matter temporarily, they may change or restore it when it has been disturbed, but such substances are poisons just the same, although they may be temporarily used for valuable purposes. All substances not foods shorten life when they come in contact with the protoplasm of the body, provided the amount taken is sufficient to affect it at all.

Poisons may be classified in three groups: (1) volatile poisons, (2) fixed organic poisons, and (3) fixed inorganic poisons. Following is an outline of the most common poisons.

(1) *Volatile Poisons*

Yellow phosphorus	Acetone	Alcohol
Hydrocyanic acid	Nicotine	Formaldehyde
Phenol	Chloral hydrate	Volatile oils
Chloroform	Aniline	

(2) *Fixed Organic Poisons*

Picrotoxin	Nicotine	Pilocarpine
Colchicin	Benzoic acid	Narcotine
Picric acid	Aniline	Hydrastine
Caffeine	Veratrine	Quinine
Acetanilide	Strychnine	Physostigmine
Phenacetine	Brucine	Morphine
Antipyrine	Atropine	Apomorphine
Salicylic acid	Cocaine	Oxalic acid
Veronal	Codeine	

(3) *Fixed Inorganic Poisons*

A. Mineral Acids

Sulphuric acid	Hydrochloric acid
Nitric acid	Muriatic acid

B. Heavy Metals

Copper	Arsenic	Lead	Silver
Mercury	Antimony	Barium	Zinc

C. Gases

Carbon Monoxide	Hydrogen Sulphide

D. Non-metals

Iodine	Bromine

A glance at the outline will show that most of the fixed organic compounds named belong to a class of substances known as alkaloids. These substances are found in plants and are of a nitrogenous, organic principle, alkaline in reaction and basic in properties. In most cases the alkaloids have an important physiological effect. They occur both in the liquid and solid form. Liquid alkaloids are volatile, having a disagreeable odor, somewhat ammoniacal. Solid alkaloids are without odor and are generally white in color, crystalline and bitter.

The treatment for poisoning depends largely on the form in which it occurs and a physician's aid should be sought immediately. However, loss of time or waiting may result in death. The following suggestions may be useful in meeting emergencies of this type. A life may be saved by provoking vomiting, by the use of bland liquids, stimulants, or antagonists.

To provoke vomiting, warm water may be used, with or without mustard, or a finger may be thrust down the throat. It is best to give large quantities of warm water whenever vomiting is to be excited. If vomiting cannot be provoked in this manner, the stomach pump or a reliable emetic should be used under a physician's direction. Bland liquids are milk, raw eggs, some sort of oil, mucilage, barley water, etc.

Stimulants such as tea, coffee, whiskey, wine or ammonia may be used. One cc. of ammonia in 250 cc. of water is sufficient for a dose. In giving tea or coffee one does not have time to wait and must not prepare it as if making it for the table, but he should mix hot water and the leaves or grounds, squeeze them well, stir together, and give the whole, leaves, grounds and everything. The most useful and handy stimulant around the laboratory is ammonia water.

Antidotes may be divided into two classes, alkaline and acid. Alkaline antidotes which are most likely to be at hand are ammonia and water (the preparation should contain 2 cc. of ammonia in 500 cc. of water),

soap and water, lime, whiting, soda, chalk, plaster, magnesia, white wash, and even wood ashes. Acid antidotes most commonly accessible are acetic acid, hydrochloric acid, vinegar, or lemon juice. In giving an antidote, it is well to remember that it is not always necessary to wait for it to dissolve, but that it may be stirred up with water or any harmless liquid and swallowed immediately.

Antagonists are drugs which physiologically oppose poisons, as atropine to opium, chloral to strychnine, or pilocarpine to atropine. These should never be given without the directions of a physician.

Following is a table containing brief suggestions for the proper treatment of those forms of poisoning likely to occur around a laboratory.

Poison	*Treatment*
Nature unknown	Provoke repeated vomiting Give bland liquids Stimulate if necessary Keep up breathing
Acids: Sulphuric Nitric Hydrochloric Oxalic	Give an alkali soap, soda, lime-water, or magnesia Provoke vomiting Avoid stomach pump Give ice cream and bland liquid Secure rest Stimulate if necessary Feed by enema
Hydrocyanic acid and Potassium cyanide	Stomach pump or emetic Stimulate, potassium permanganate Give dilute ammonia water, chlorine water Cold affusions
Carbolic acid and creosote	Give Epsom salts, dilute sulphuric acid, glycerine and oil Stomach pump or emetics White of egg, amyl nitrite. Stimulate, artificial heat
Alkalies: Ammonia Soda Potash Lye	Give dilute acid, hydrochloric, acetic, vinegar, lemon juice, orange juice or a fixed oil Give bland liquids Secure rest Stimulate if necessary
Arsenic: Paris Green Scheele's Green Fowler's solution	Stomach pump or emetics Give hydrated oxide of iron or dialyzed iron and magnesia Give castor oil Secure rest Stimulate if necessary
Acetate of lead	Stomach pump or emetics Give Epsom salts or dilute sulphuric acid Milk, raw eggs, and water

Poison	*Treatment*
Mercury: Corrosive sublimate	Emetics Bland liquids
Antimony Tartar Emetic	Give dose castor oil Stimulate if necessary
Copper Salts	Give albumin (milk, raw eggs) Stomach pump or emetics Give bland fluids
Phosphorus	Provoke vomiting by repeated five-grain doses of sulphate of copper Give dose of magnesia, or oil
Nitrate of Silver: Lunar caustic	Give strong salt and water Provoke vomiting Repeat many times
Iodine	Stomach pump or emetic Give starch and water Give bland fluids
Opium: Morphine Laudanum Paregoric, etc.	Stomach pump, emetic, potassium permanganate by mouth Oxygen inhalations, artificial respiration
Chloral: Paraldehyde	Stomach pump, or emetic Artificial heat, massage Stimulate, strychnine Artificial respiration
Nux Vomica: Strychnine Picrotoxin	Stomach pump or emetic, animal charcoal or tannic acid, bromide and chloral, amyl nitrite, chloroform or ether. Artificial respiration
Aconite: Veratrum viride	Stomach pump or emetic Stimulate, heat, atropine Artificial respiration
Belladonna: Atropine	Stomach pump or emetic Artificial heat, morphine Artificial respiration
Alcohol	Provoke vomiting Give ammonia and water
Poisonous gases: Carbon monoxide Hydrogen sulphide	Fresh air, oxygen Artificial respiration Amyl nitrite or nitroglycerin Stimulation

The preceding table contains some suggestions which would not be safe to attempt without the guidance of a physician. However, with these in mind, the instructor will be more at ease, should he be forced to face such an emergency, than if he had no idea as to what should be done.

THE PROBLEM OF HIGH-SCHOOL CHEMISTRY*

GUY CLINTON, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

In this problem three principal factors will readily be recognized: *viz.*, matter, arrangement, and method. Very material progress has been made on the first of these by the Committee under the direction of Dr. Neil Gordon. The other two shall claim our principal attention. They are, of course, in many ways interdependent.

It will probably never be admitted that there is any one precise arrangement of topics which is essential to a good course in chemistry. The subject matter lends itself to so many lines of cleavage and cross systems of classification that there is great room for the proper exhibition of individuality. Nevertheless, there are certain fundamental principles, which, if not followed, would mark as a failure any attempt to make such a course.

A vital principle in *arrangement* is, that what precedes should prepare for what follows; or, stated more broadly, that which follows should not presume knowledge beyond what the preceding exercises give opportunity to learn. It is not wise to judge critically a student's knowledge of the term "catalyzer" merely from his casual reading of what it means, or from a single illustration given by the teacher. While the matter is under discussion, the student should have an opportunity to judge among several illustrations or experiments, some of which contain examples of catalyzers. I would not raise the question incidentally whether a given reaction is endothermic or exothermic until after these ideas had been developed through an exercise involving experiments and judgment—words of explanation are usually insufficient. I would not call upon a student to write an equation involving the exchange of radicals until after "valence" had been taught. I would not give a quantitative experiment to find the weight of a liter of oxygen, or the equivalent weight of a metal through its displacement of hydrogen until after the meaning and application of the gas laws had been developed through the solution of numerous problems. I would delay the performance of "practical experiments" until after at least some of their chemical principles had been introduced and would remain silent on such principles as had not received previous attention. It is better to group experiments about principles rather than principles about experiments.

* Read at the sixty-ninth meeting of the American Chemical Society at Baltimore, Md., Apr. 10, 1925.

As a step toward method we must decide whether to give a lecture course, a textbook course, or a laboratory course. All of these factors, of course, may enter in, but which one shall be most emphasized? Prof. Alexander Smith once remarked that lectures were most excellent exercises for the lecturer, but they are very poor for the class. Whatever may be said in their favor for universities, their use in high schools should be slight, and practically confined to the time for assigning home-work. The textbook is a most important aid in teaching any subject, but to make it the principal factor in a course in science is about as effective as it would be to serve ourselves with dessert at the end of a meal by looking at the beautiful pictures on the can and reading a discussion of the delicious flavors of California fruit. Courses in most subjects deal in what has been written about them. Courses in science may be obtained from nature at first hand.

The wealth of material pertaining to chemistry is so great that the principal difficulty is to decide on what to eliminate. The writers of textbooks and laboratory manuals are impelled to undertake the impossible task of trying to include all the "practical topics" that any school may demand, however diversified this demand may be, and yet have the text serve as a guide to a reasonable course for high schools. Most high-school teachers of chemistry look upon the textbook as the course. The subject matter is new and somewhat mysterious to a class of beginners, and teachers are able to arouse a great deal of interest and enthusiasm in the early part of the course. But when the novelty wears off, they find it more and more difficult to maintain this interest as they proceed. Teachers put their classes in a position something like that of a very hungry man who is invited to a fine Christmas dinner, and when he has filled himself to the limit he is urged to eat more and more. We know why the food becomes distasteful to him; but we do not so readily recognize the necessity of giving time for *mental* digestion.

We usually approve and often applaud the speaker or writer who declares that the chief end of instruction is *not* to impart *facts*, but to develop in the student the ability to think. The frequency of this utterance might lead one to suppose that there is an issue on it strongly dividing the educational world. As a matter of fact, I think educators are pretty well agreed on this point. The disagreement, if any, is not upon the desirability of the end to be sought, but upon methods of attaining it. Dr. H. A. Cunningham in THIS JOURNAL for March* says: "We, as science teachers, are evidently making an absolute failure in our efforts to attain one of the aims of natural science teaching (that of inducing the student to think). Why are we failing?" Thus, it is seen that no definite formula has been worked out prescribing just what a teacher should do to induce pupils to think. It is with some hesitation that I enter a field of discussion

* THIS JOURNAL, II, 169 (1925).

where so much has been attempted and admittedly so little has been accomplished.

The two essential steps in thinking are (1) the discovery of principles and (2) their application. A mind stored with sound principles is quick to interpret new experiences. It is usually thought that since the text is taken up largely with a discussion of principles, the student ought to study them there, and apply them as he has need. Herein lies a fallacy. The teacher judges the text from his own point of view instead of putting himself in the student's place. Simple as many of our high-school texts are, when they deal with principles they extend beyond the experience of the average student. He must be led step by step, and not asked to make leaps and bounds in order to reach the viewpoint of the teacher and the text. The joy of discovery is one of the greatest incitements to interest. Too early reliance upon the text would be a kill-joy and rob the student of many pleasurable opportunities. He should discover principles experimentally as far as possible. The teacher should be an ever faithful guide without permitting his guidance to become too obvious. He should steer the course by a definite plan; but its unfoldment to the class should be very guarded so that the high points as far as possible may be made to appear as individual achievements of the student. An attempt should not be made to rediscover the accumulated chemical experience of the race. The teacher guided by sound judgment will choose a middle course. By definite questions, the student's attention will be directed to definite facts observable in his experiments, and his path toward generalizations strewn with suggestions. Yet something must always be left to his judgment. There must be an opportunity to err. Students are, of course, working in classes, and after all members of the class have committed themselves in writing, correction of their mistakes affords the teacher the best opportunity to impart the idea of scientific procedures. The student's first efforts are likely to be disappointing. Practice, however, brings about rapid improvement. Correction need not call for rewriting the notes. After being duly marked there is no harm in allowing the errors to stand. Opportunities should be afforded the students to apply his principles as they are discovered. He should be made to understand that this is the most important test of his progress.

Let it be supposed that the attention of the class has not been called to the law of conservation of matter. A candle is weighed, lighted while on the balance, and the class notes the change in weight due to burning. The students individually weigh out portions of copper, iron powder, or other metals, and note the effect on weight due to burning them in their crucibles. Another candle is burned under a lamp chimney containing materials that will absorb the products of combustion. The whole apparatus being reweighed, the effect on weight is noted. A small piece of

phosphorus is suspended by a deflagrating spoon or other device in a florence flask and the flask stoppered air-tight. After weighing, the phosphorus is set on fire with a burning glass. It is again weighed and the effect of burning noted. Two test tubes containing different solutions are put in a beaker and weighed. The solutions are then poured together in one of the test tubes, the precipitate noted, and the whole system weighed again. The composition of a candle is explained, and the nature of the products of combustion called to mind from previous work. From these data the student is expected to discover the law of conservation of matter. Most of them succeed very well.

As a guide to method, we recognize that the two essential steps in learning are *experience* and *expression*. Laboratory experiments afford the best opportunity for chemical experience. They do not, however, have their full significance unless they are performed in their logical sequence. Until the proper steps have been taken leading up to the discovery of an important fact, the student is of that scriptural class, "which have eyes but see not." Order is therefore an essential part of method.

Sensations which pass through consciousness without finding expression are little more than the plastic materials or rough stones out of which the sculptor fashions his images. They lack form and precision, and their impress on the mind quickly fades. Accurate expression is, therefore, a matter of the highest consideration. Shall the student be left to choose his own words? High praise is often given to an author or a speaker who expresses scientific ideas in common language, avoiding technical terms and using circumlocution to convey the idea. Left to himself the student would have to follow this plan; and, being inexperienced, he would likely fail to express himself clearly. Just as each country has its own language best suited to express its ideas, emotions and customs, so each science has its own peculiar vocabulary just suited to express the facts and principles which constitute it. If we feel impelled to shun the technical terms of a science, we ought not attempt seriously to study it. We would not be able to obey Hamlet's injunction: "Suit the action to the word, and the word to the action." There is no accurate way to express scientific ideas except in technical terms. Conversely, when we use technical language with a clear understanding of its meaning, we have made good progress in learning the science to which it belongs.

We may think of three sources of help to the student in learning chemical terms. He may get them from the oral explanations and discussions of the teacher; he may get them by reading the textbook; he may be given them in his printed laboratory directions. The first method is not wholly satisfactory because the individual students require more repetition than the teacher can afford to give. The trouble with the second plan is that the proper amount of help cannot be given without giving too much.

Just when a student is writing his notes he is in most need of assistance in selecting his terms, but it would spoil the object of the experiment for him to copy answers to the questions, or formulas and equations from the texts, because judgment on these is the specific object of the laboratory exercise. All needed help can be given in the laboratory directions without destroying the proper object of the experiments. The explanations may be referred to again and again until by usage the student has mastered the terms. This is the plan I have used for several years and found it to be quite satisfactory.

Concerning method, there is another question which should receive some attention: Should each student set his own pace in laboratory work, or should all members of the class perform the same experiment during the same period? There are good points in favor of each of these opposing plans, and early agreement is not to be expected. I shall present a few points in favor of the latter plan, and leave it to others to defend the former.

First, the teacher's direction of the class is simplified when he has only one or two experiments to think about instead of many. He must often change the material or apparatus due to shortage or special conditions, and these adaptations may be made once for the entire class instead of once for each student. Second, all students will be equally ready for interpreting and making notes on experiments that are demonstrated. Third, I know of no other way to make a course center in the laboratory. After interpreting an experiment in their notes, students need an opportunity for discussion and drill upon the points covered. Instead of individual instruction, we have the advantage of class recitations.

Some attention must be given to the difficulties of the plan. Students do not normally work at the same rate; some are quicker in performance than others. This difficulty, however, has to be met in using either plan, unless the teacher excuses the slow ones from a part of their work. If they get behind on some of the earlier experiments, left to themselves, they will get farther and farther behind as the course proceeds. It is better to correct this fault when the difference is small rather than wait until it becomes impossible. A normal pace must be set for the class. The rapid workers who finish their work in shorter time can increase their skill by assisting the teacher with laboratory preparations, and occasionally be given additional experiments for which they may be allowed premium credit. The very slow students, and those who miss part of the work because of absence, must spend overtime in the laboratory in order to bring up back-work. During the regular class time they do the work required in the lesson for the day. It is very advantageous to divide the period so that all work on experiments at *one* time, and all write notes at another. This enables the teacher to control the conditions under which the notes are written.

Perhaps it would not be out of place to say something about methods of grading students. A student's industry and often his interest in a subject is powerfully influenced by his belief in the fairness or unfairness of the teacher's system of grading. The normal student is not pleased with, nor does he have the proper respect for a teacher who is considered "easy." On the other hand, a teacher's tests should not over-reach or go beyond the work on which the class has been drilled. Tests should be within the ability of 80% of the class. Unusual questions demanding the highest type of ability should be reserved for other class exercises.

The teacher's method of grading should be definite and not so often changed as to appear fickle. He should take his students fully into his confidence. As soon as practicable after an exercise is finished, the student should be acquainted with his rating, and both student and teacher should be bound by the record. The final rating should be determined by careful bookkeeping and the account open for inspection by all concerned. *Ratings are the terms of value by which the student is outwardly compensated for complying with the requirements of the course.* He should be no more in doubt about the progress he is making than he would be on money due him were he working for wages. Poor work at one time can only be balanced by better work at another. No one is strong enough to perform both yesterday's and today's tasks at the same time. Duty's account should be balanced daily, the gains carried forward, and the losses written off.

THE TEACHING OF SCIENCE IN THE HIGH-SCHOOL

JESSIE SPENCER, ALBUQUERQUE, N. M.

These ideas are not new or especially good, but merely a summary of the situation which is facing the high-school science teachers of today. We have a great opportunity, as well as a great responsibility. Who is there, young or old, educated or uneducated, who is not interested in science in some of its many forms? Then we, as science teachers, are met by a condition which is by no means true of all teachers. The pupils come to us alive and eager for more knowledge of our subject. Do many enter into the conjugation of "amo, amas, amat" or the proof that two triangles are similar if they have two angles of one, equal respectively to two angles of the other, or whether they should say "It is I," or "It is me," with the same eagerness that they discuss scientific facts? A child likes to let his imagination lead him on. He will speculate much too long for class purposes unless he is directed into other channels. Nearly every young person is interested in living things, and the actions and habits of living things. In fact, it is interesting to any of us to know

that baby ants have their nurses who take them out for an airing, that some ants take care of the plant lice, moving their babies from one plant to another, so that the lice will have plenty of food on which to live, and that some woodpeckers seal up the mother woodpecker in her hole in the tree while she sits on the eggs to keep them warm.

Now what has all this to do with science teaching? Just this, since we have pupils with such intense interest, or if not already present, so easily awakened, has not the public a right to expect much of us, perhaps more than from any other teachers?

Secondly, since there is such widespread knowledge of science by the layman as well as the professional man, in this day of radio, airplanes and power machines of all kinds, does it not place a heavy responsibility on our shoulders? We must at least maintain the interest and we must increase the knowledge. How much should a teacher know to teach science? I hold up my hands and gasp. What shouldn't he know? He must not pose as an authority on all subjects, but so many different things need some knowledge and direction. A friend told me of walking to school with a fifth grade boy one morning. The boy asked if he would please explain a "proton" to him, saying that he felt that he understood an "atom" and an "electron" pretty well, but the "proton" was not quite clear.

When fifth grade children are able to talk understandingly of electron, proton and atoms, how much should the high-school teacher know in order that he may add to the pupils' knowledge and not be surpassed by them? He must have a considerable knowledge of nearly all sciences and above all an interest in science and a strong desire to keep up with scientific developments, for our science, unlike many other subjects, is constantly changing.

Three main objects should be made the goals. First, a knowledge of the general laws governing the universe and an exact knowledge, not too technical, concerning common phenomena. Second, an increased, stimulated and inquisitive interest of the pupil in the world about him. Third, a recognition of problems when presented, and a method of attacking them.

Too many stop with the first, but it must not stand alone. Knowledge will come through interest, if properly directed. However, I believe the "project" method is impracticable in a large class with limited time. More than that, I believe none of us retain our knowledge unless we use it many, many times in many different situations. "Projects" may follow and indeed I find many of them do, but they cannot well lead the way in most of our high-school classes.

Frequent testing causes the pupils to select outstanding facts and laws, it also causes him to compare, contrast and apply them. It enables him to judge for himself how nearly he has mastered his work. It enables the teacher to check his accomplishments.

Some interesting tests for the purpose of comparing our work with that of others, are the "Rich Chemistry Test," published by the Public School Publishing Co., Bloomington, Ill.; the "Gerry Tests of High-School Chemistry" published by The Harvard University Press, and the "Powers Chemistry Tests" published by the World Book Co. The first two are completion or alternate response tests, they have been used rather widely, and the results are obtainable. This enables us to check our results with those of other schools. Pupils also like to know if they are measuring up to the standards set for others.

We are not entirely dependent, however, on already prepared tests. Could we not devise tests for ourselves and at least compare results with one another? I believe it would not only stimulate our pupils and ourselves, but enable us to discover who has superior methods for presenting particular topics, and thus all might profit.

Objective number two is the development of an increased, stimulated and inquisitive interest of the pupil in the world about him.

I know of no better way to accomplish this than by extensive reading and by study of the life right about the pupil. My methods of encouraging the former are somewhat as follows: Definite assignments are not made. The only requirement is that one or two oral reports—depending on the class—be given each semester. When the magazines arrive I report to the class that such and such magazines contain such and such articles this month. For example one article is "The Wonderland of Ice" which tells how icebergs are formed and why they are so dreaded by ships. I think you would enjoy reading it. There is another about the "Chigger." How many of you have ever had a chigger? Do you want to know what the insect which buries itself under your skin looks like and what happens to it after it bores in? There is another about atoms and electrons. Would anyone like to report on any of these? The result is usually that three or four want the same one. The pupils then agree among themselves as to who shall give a particular report. I tell them that any of them may read the article but, of course, we have time for only one to report to the class. When the report is given there are many who are ready to correct any errors of statement or to supply interesting facts which were omitted. Often the pupil comes back with this statement, "I read that book or magazine from cover to cover." If we can maintain this interest do we need to fear for our subject?

Books are handled in about the same way as the magazines. While discussing foods, suggest that there are some interesting pictures of white rats showing the results of different feeding to be found in Caldwell and Slosson's "Science Remaking the World." While studying corn or some product of corn, suggest that there is an interesting chapter on corn products in Slosson's "Creative Chemistry." The chances are they will read

that chapter as well as two or three others. Reports to the class are often asked for. I would rarely suggest reading an entire book but it is interesting to see how the habit of reading grows and how soon they are reading the entire book and asking for more. My pupils coax for these reports to the class and try to make me forget that they have given two or three and that therefore it is someone else's turn.

The pupils should be introduced to as great a variety of reading as possible. If we can do this and also maintain this interest several months it will probably mean that the pupil will continue to read, to be interested and to grow the remainder of his life. He will then not only find a source of enjoyment but he will have gained much more than he would otherwise have gained in the scant time allotted for class. The teacher's work and influence does not end with the semester.

In the magazine rack should be found *Scientific American, Science News Letter, Nature, Popular Science, Journal of Chemical Education.*

A few of the books found on the book shelves should be: Thompson's "Outlines of Science," Slosson's "Creative Chemistry," "Ants, Their Structure, Development, and Behavior," by Wheeler, "Social Life in the Insect World," by Fabre, "Everyday Mysteries," by Allott, "Chemistry of Commerce," by Duncan, "Science Remaking the World," by Caldwell and Slosson, "Life of Pasteur," by Vallery Ràdot, "Letters of a Radio Engineer to His Son," by John Mills, "The Story of Drugs," by H. C. Fuller.

New books must be added every year if our work is to be kept up to date with rapid development. The interests of the pupils and the locality must also influence selection.

As a stimulant to practical work and much more economy of time than numerous and too often aimless field trips, is constant encouragement on the part of the pupils to bring all interesting things or information to the laboratory. When these things are brought the interest of the pupil is a function of the interest of the teacher. The pupil has a special interest in a thing if he is the finder and sole owner. He also is anxious in finding interesting things which surpass those of others. Our collection so far this year includes centipedes found in the bath tub, tarantulas found under the car, pupas found under the lilac bush or in the crevices of the house foundation, horned toads, a few rattlesnakes, many lizards, many praying mantids, a rhinoceros beetle, some splendid specimens of the hawk moth, as well as many unusual types of flowers, different kinds of twigs and leaves. One day a boy came in much excited, saying that he had found two kinds of leaves on the same tree and would scarcely believe it when told that the mulberry usually grew that way.

Objective three, the recognition and method of solution of problems, belongs primarily to the laboratory. The present tendency is toward

much less laboratory work and much more demonstration. Perhaps many principles will be better understood if the teacher is able to demonstrate them accurately, than if the pupil is permitted to obtain mediocre results while his mind is on many of the details of the experiment such as the manipulation of the apparatus. On the other hand the pupil often learns many other things besides the main objective of his experiment just by handling his own tools.

My experience in demonstration is that a pupil often does not observe much that you expect him to observe. Therefore, the best method seems to be to direct attention and thought to particular points asking that the answers to a few important questions be written out. These answers must be short, concise and definite. This aids the pupil in classifying his own thoughts and in deciding for himself whether or not he really understands the work as well as forcing him to do a little thinking for himself on the subject. After he has had a chance to solve the problem for himself it is taken up in class which enables him to check his own reasoning and solution.

All of our laboratory work needs careful, thoughtful consideration and much reorganization. Much of the old should be thrown out and many changes should be made.

In conclusion, may I say that I do not see how a person today can be considered educated in the smallest sense of the word without at least some knowledge of both natural and physical science. The study should be begun in the lowest grade and continued through school.

The science teacher has a field which is unlimited in scope and the results of his work are immeasurable. Our teachers are now doing as good work as any teachers but we must keep alive, awake and progressive. Our subject will not wait for us.

MUSEUM REACTIONS*

R. A. BAKER, SYRACUSE UNIVERSITY, SYRACUSE, N. Y.

Although the present tendency is toward individual instruction in the chemical laboratory, the experimental lecture is still an integral feature of most elementary chemistry courses.

The average student cannot possibly gain as much from an experimental lecture as he could from properly planned individual assignments covering the same ground. If the group of students is large most of them are located so far from the scene of action that they cannot see the details of the set-ups. They form the habit of awaiting a flash of light or a loud noise or a word from the instructor as the signal that the expected has happened.

* Paper read before the Division of Chemical Education at the April, 1925, Meeting of the A. C. S.

No amount of explanation, either before or after the demonstration can make up to them for the lack of contact with the apparatus and materials.

During a lecture the instructor cannot consider each individual in the class. He must consider the class as a whole. Admittedly, therefore, at the close of the lecture, the poorer students are suffering from mental indigestion and need supplementary instruction. Very shortly after the lecture, he must clear away his set-ups in preparation for the next class, and unless the lecture apparatus is kept intact in the museum there is practically no opportunity for any student to become acquainted with either the apparatus or the details of the reactions *at his leisure.* The actual experiment should in some way be made to live in the mind of every student.

Many reactions may be harnessed so as to proceed more or less uniformly for considerable lengths of time. One need only assemble the necessary apparatus and materials, start such a reaction going and leave it for inspection. Meanwhile the poorer students may study the "experiment" at length, until *each* one has mastered it. The principle involved and any unusual features may be emphasized by means of placards (there are cross-section diagrams of any parts of the apparatus which are not plainly visible). The instructor may even carry out a very definite assignment by including on the placards carefully chosen questions and references for library work or consultation. In any case healthy discussion is stimulated among the onlookers. Sometimes it may seem wise to bring the set-up to the lecture table to repeat the experiment before the whole class.

The term "Museum Experiment" seemed appropriate for these unattended demonstrations of reactions which have a long "shelf life." The requirements are obvious: There should be a visible change; it should be continuous or recurrent; the reaction as well as the apparatus should be simple enough in principle to permit clear, concise exposition by means of charts; the apparatus and materials should be comparatively inexpensive on account of "shoplifting" and there should be a minimum of danger to property or observers in case of accident.

While these museum experiments may very effectively supplement formal instruction in the laboratory, they probably possess a greater value in stimulating popular interest in chemistry. They have proved to be extremely successful in connection with chemical "expositions," "shows," "fairs" and "open houses."

Although static exhibits require least attention, experience has shown that they do not attract the casual visitor as do those which are advertised in some dynamic fashion. Nor are displays of products and apparatus ever as successful as actual demonstrations of reactions or processes. If upperclassmen, graduate students or instructors are available to act as demonstrators no other device is necessary. In their absence, however,

each exhibit must be its own "barker." By definition, the museum experiment, with its accompanying charts, can play this role very effectively. Once attention is attracted, real interest is not hard to arouse, since there are no fictitious values in chemistry.

I shall confine myself to the description of a few tested museum experiments, without quoting "lines" for the placards. The experiments have been selected from various sources, individual credit for which I have not attempted to give. It is assumed that the reader is familiar with the following books: Newth, Chemical Lecture Experiments—Longmans; Benedict, Chemical Lecture Experiments—MacMillan; van Klooster, Lect. and Lab. Expts. in Physical Chem.—The Chem. Pub. Co. The last-named author in particular, gives valuable references to the original literature.

As cheap materials whose continuous flow is assured, air, water and illuminating gas present the greatest possibilities for the average laboratory, although the employment of other substances is limited only by one's ingenuity in devising set-ups. A comparatively simple experiment offers an almost unlimited field for instruction. The following are a few illustrations:

Combination of Gases

A. Reciprocal Nature of the Combustion of Illuminating Gas in Air (Fig. 1)

A lamp chimney is closed at both ends with pieces of asbestos board. *a* is an elbow tube which serves as the gas inlet, *b* and *c* are short lengths of 0.5 cm. tubing. With everything in place except *b*, the chimney is filled with gas which is then lighted at *c* and at the hole for *b*. The tube *b* is now inserted and carries the flame *d* inside the chimney.

B. The Bunsen Burner Principle

1. Construction of the Burner (Fig. 2)

A glass model is constructed from a straight piece of tubing *a*, having a diameter about 2 cm. and a length of 30–40 cm., and an elbow tube *b*, constricted at one end to a 1 mm. tip, which serves to admit the gas. The distance between the lower end of *a* and the tip of *b* will depend upon the gas pressure and the diameters of *a* and the tip, but need not be greater than 3 cm. to produce a very striking appearance.

2. The Luminous Flame. Same as B-1, save that the gas tip is thrust through a stopper in the lower end of *a* to prevent the entrance of air.

3. Glass Blast Lamp.

A small side arm is sealed about in the middle of a 10 cm. length of hard glass tubing (diam. 2 cm.). A one-holed stopper in the lower end admits a thin straight tube which extends the length of the larger tube and ends in a 2 mm. tip. Air is blown through this inner tube while gas is admitted through the side arm.

4. ½ Gasoline Blow-torch.
5. Oxy-hydrogen flame. Tanks of O_2 and H_2 and a special burner are

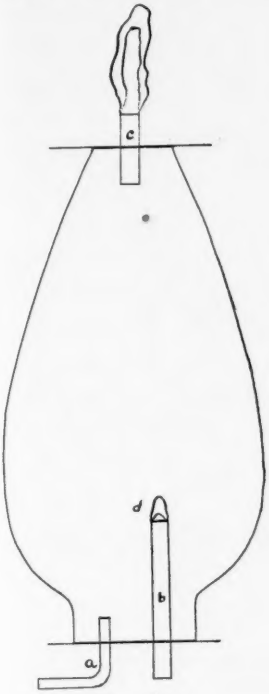


Fig. 1

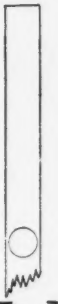


Fig. 3

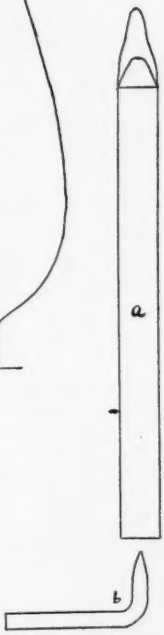


Fig. 2

Fig. 5

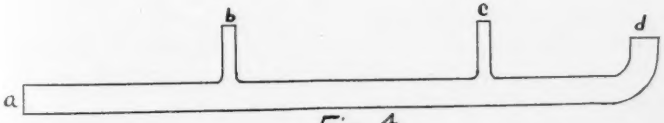


Fig. 4

necessary. Onlookers are directed to hold a piece of iron wire in the flame. The flame may be directed against a piece of CaO.

6. Burner from Gas Cooking Stove.

C. Structure of the Flame

1. Ordinary burner with match-head supported by means of a wire just inside the top.

2. Ordinary flame with glass tube introduced at an angle, the end being kept just below the inner cone; the unburned gas which escapes through this tube may be burned at its top.

D. Propagation of the Flame; Kindling Point of the Gas; Safety Principle

1. Flame is maintained at a distance from the outlet of the burner by holding a piece of wire gauze (*a*, Fig. 3) at about the spot where the inner cone of the non-luminous flame would strike it, turning on the gas and lighting it above the gauze only.

2. Fisher Burners. Show 3 burners: No. 1—with grid removed and air-holes open; No. 2—with grid removed and air-holes closed; No. 3—with grid in place and air holes open; No. 4—with grid in place and air-holes closed.

E. Enriching a Gas

Distribute illuminating gas through a Y-tube to two burners. Before reaching one the gas is passed through a gas-washing bottle containing C_6H_6.

F. Production of Solid NH_4Cl from NH_3 and HCl Gases

HCl is produced by dropping conc. H_2SO_4 from a separatory funnel onto a strong NaCl solution in an Erlenmeyer flask. While NH_3 is best gotten from cylinder of compressed gas, it may be made by dropping saturated NH_4Cl solution on solid NaOH in an Erlenmeyer. The two gases are led through glass tubes and caused to impinge on each other underneath a large funnel (hood). Solid NH_4Cl collects.

Osmosis

A. Natural Membranes

General principles and technique are described in texts of General Science, Plant Physiology and Chemistry. The following membranes have been successfully employed; skins of apples, oranges, lemons, apples, carrots, beets, eggs; bladder, intestine. Most convenient system is sugar solution: membrane; pure water.

B. Artificial Membranes

1. Collodion bag (using sugar solution)
2. Mineral flower garden (The conventional arrangement, using a dilute

solution of Na_2SiO_3, into which small crystals of heavy metal salts have been dropped).

Distillation

A. Distillation of Water under Normal Pressure

Permanganate solution in a 1 liter distilling flask, fitted with a thermometer and connected to a glass condenser and receiver.

B. Distillation of Water under Reduced Pressure

Same arrangement as in A, save that the receiver is a 500 cc. distilling flask, connected tightly to the inner tube, and the side arm of which is attached to a glass water suction pump. A boiling point 30 degrees below normal is easily maintained.

C. Boiling of Liquid Air

500 cc. of liquid air in an unsilvered Dewar flask will boil quietly for at least 10 hrs.

Electrolytic Phenomena

A. Gravity Cell in Glass Jar, Connected with Small Lamp

B. Electrolysis of H_2SO_4 Solution, Collecting the Gases

Subatomic Phenomena

A. Geissler Tubes, Containing Samples of Different Rarified Gases, Connected with Induction Coils

B. Radium or Radium Emanation, Using ZnS to Magnify the Effect

If a small tube containing emanation is broken inside a bulb coated with ZnS, the latter will glow for some time. Ten millicuries are sufficient for a 200 cc. bulb for one day.

Reactions between Solutions

When two solutions react to produce a gas, an insoluble solid or some substance with a different color, the reaction may be demonstrated effectively by the following simple scheme (Fig. 4): Two short side arms *b* and *c* are sealed onto a piece of 1 cm. tubing about 1 m. long. To these are attached aspirator bottles, separatory funnels, or any convenient vessels from which two different liquids may be admitted into the long tube. Screw pinch cocks control the flow from these sources. Water from the hydrant is admitted at *a* and flows out at *d*. The rate of flow is adjusted to suit conditions, but should not of course be sufficient to back the liquid up into *b* and *c*. If a solution of Na_2CO_3 is allowed to flow slowly into *b*, while a solution of $CaCl_2$ is admitted at *c*, a white ppt. will form at this spot and a milky liquid will flow out at *d*. Many other com-

binations at once suggest themselves. A third side arm may introduce still another reagent.

Oxidation of Phosphorus under Water

In Fig. 5 about 0.5 cc. of yellow phosphorous is placed in an Erlenmeyer flask containing water to a depth of about 4 cm. The flask is heated (not to boiling) over a low flame. The whole set-up is placed over a bed of sand. A conveniently bent tube is placed in the flask, through which a current of air may be blown onto the phosphorous.

MANIPULATION OF GAS HOLDERS BY ELEMENTARY CHEMISTRY STUDENTS

C. A. BRAUTLECHT, UNIVERSITY OF MAINE, ORONO, MAINE

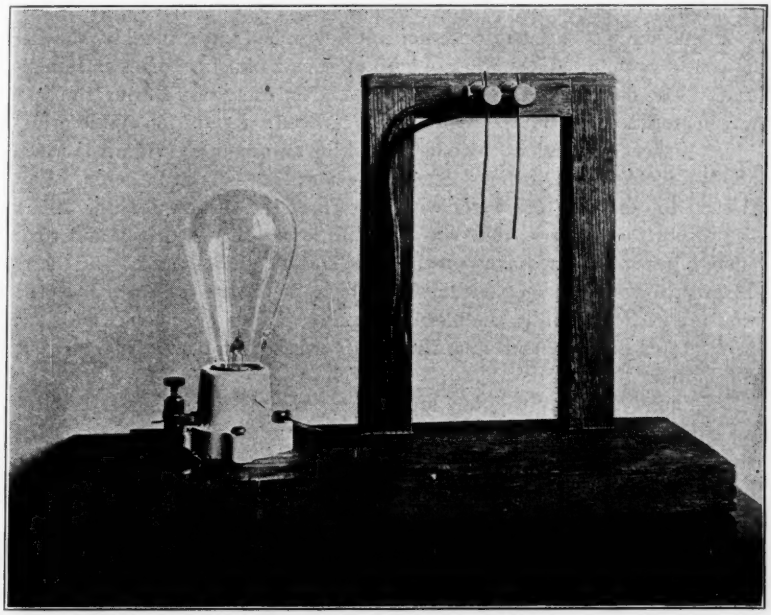
The supplying of gases such as hydrogen and oxygen to laboratory classes is often a problem. Of course, the student should make some of the gas but the supply of containers, space and time may be lacking to make all that is needed and then a laboratory supply should be available. This procedure applies to other gases which are practically insoluble in water. Under average conditions the writer has found the following procedure to work very satisfactorily.

The ordinary gas holder of the Berzelius or Papy type of twenty or forty liters capacity, easily portable between lecture, laboratory and store room, is filled with gas from a steel cylinder or generated during a lecture demonstration. A rubber tube is fitted with a short piece of heavy wall glass tubing drawn to the proper size opening to yield the proper flow of gas with the pressure tube of the gas holder filled. The one end of the tube is attached to the gas outlet tube of the holder, the other to the tray in the water pan. A 2.5 l. or even 1 l. bottle of water is inverted in the pressure tube funnel of the holder. With the stop-cock of the pressure tube open during the period, the student simply opens wide the one gas outlet cock displacing water from the bottle above the outlet of the tube in the water pan. This requires only about one-half minute and there is little, if any, waste. When the water supply bottle above the pressure tube is empty the student desiring gas fills and replaces it. It is possible to compute the quantity of gas needed for a class and provide it with certainty. The small amount of time required to fit up and care for the gas holder is well repaid in saving time and material and in getting results.

AN APPARATUS FOR CONDUCTIVITY EXPERIMENTS

HARRY CLIFFORD DOANE, GRAND RAPIDS JUNIOR COLLEGE, GRAND RAPIDS, MICH.

The form of apparatus shown in the illustration has proved convenient, both for demonstration and for laboratory experiments. Specimen



tubes one inch in diameter are used for electrolytic cells. The electrodes are nickel, and are short, so that the cells, which are held in the hand, can be quickly changed.

The base is $5^1/_2$ inches by 12 inches and the upright support is $8^1/_2$ inches high by $5^1/_2$ inches wide. The binding posts are double.

LOS ANGELES MEETING OF THE A. C. S., AUGUST 3–8

Abstracts of all papers which are to be read in the Division of Chemical Education at the Los Angeles Meeting of the A. C. S. should be sent *at once* to B. S. Hopkins, Secretary, University of Illinois, Urbana, Ill. A symposium on, "What Are We Teaching Chemistry For?" has been scheduled. Many interesting papers are expected from California which is recognized as one of the great educational centers of the world. Only prompt action on the part of authors will permit the publication of the abstracts before the Meeting.

A GRADING HELP

JOHN M. MICHENER, HIGH SCHOOL, WICHITA, KANSAS

The questions on the new standard tests, such as for chemistry and physics, generally have blanks to be filled in with a word or two, words to be underlined, etc.

When such tests are on printed or mimeographed form, then, by the use of a sheet of celluloid, the work of grading such a paper becomes extremely easy. The method described here was used in the Army during the last war in grading tests, but the writer has never seen a description of it in print.

Get a sheet of celluloid, such as is used for automobile curtain windows, about 8 inches by 12 inches. Such a sheet will cost about 20 cents. Lay this on top of your test paper with enough of the sheet extending above the top of the paper so that you can hold it in your left hand, and with enough paper left uncovered on the right so that grades can be put there. Then write with your pen on the sheet above the blanks the word or words that are needed to fill in the blanks properly. If answering the questions necessitates simply underlining the proper word, then place a line on your sheet under that word.

It is now very easy to grade any paper. Simply lay the marked sheet over the paper to be graded so that guide points previously placed on the sheet coincide with some chosen word on the paper. The student should have the same word under the word on the sheet or a line under the line drawn on the celluloid sheet to have answered the question correctly.

The above method is the easiest that has come to our attention. The whole paper is before your eyes, if you care to glance at it. The answers on the celluloid bring your attention to the critical points in the questions and then correct answers and the answers given are close together for easy and accurate comparison. Grading becomes a matter of little skill and time and can be turned over to a person unfamiliar with the subject, with the assurance that the grading will be done correctly and easily.

The ink can be washed off easily with a wet cloth and then the sheet is ready to be used again.

We find the method so satisfactory that we mimeograph all of our tests, so as to be able to use this method of grading the papers.

A LABORATORY NOTE BOOK

WALTER O. WALKER, WILLIAM JEWELL COLLEGE, LIBERTY, MISSOURI

The writer has for the past four years employed a particular type of note book for use in the laboratory. The note book itself is not unique, neither is the employment of carbon paper with it a startling discovery. Each student is required to obtain a note book of the type decided upon by the instructor. A sheet of carbon paper is furnished by the department. This notebook must be present at all laboratory periods and notes on the nature and results of the experiments entered therein. It is not necessary for the students to write out all the points of the instructions; a bare outline is sufficient. Results should be entered clearly and concisely. A little careful training, a lecture on note taking, and criticisms of the notes will help the student to grasp the idea of note taking.

To illustrate the use of this note book, it may be desirable to follow a student through a laboratory exercise. He prepares the note book by inserting the carbon paper so that a clear copy will be made. Next his name is written, together with the date and the nature of the experiment. It is necessary that these points be observed, otherwise confusion may arise, not only on the part of the student, but also on the part of the instructor.

After completing an experiment (or a portion, where there are several distinct parts to a general experiment) the student is required to bring his note book to the instructor for a conference. If the notes are correct, the instructor O. K.'s the notes and the student is permitted to go on with the experiment. If the results are incorrect, the student is shown his difficulty (or a suggestion made which will make him see it) and he is required to repeat that portion of the work. In no case is he allowed to continue with the remainder of the experiment until satisfactory results have been obtained on the section under question.

At the end of the period the student removes the carbon copy and hands it to the instructor, retaining the original in his note book for his own reference. The instructor may check over the carbon copies of the students as thoroughly as he thinks necessary.

The advantages of this system are very apparent.

1. It teaches the student to take notes containing the desirable information in a uniform note book and in a uniform style. This in itself is most important.

2. It gives him a permanent record of all notes taken in the laboratory. There are no scrap paper notes to be lost.

3. The instructor is able to check up the work of the student in the laboratory while the experiment is fresh in the student's mind. He is reasonably certain that the corrections are properly noted by the student.

4. The carbon copies afford the instructor a ready reference list as to the progress of work in both class and individual cases.

5. This system reduces to the minimum the unfortunate tendency of many students to depend upon their neighbors in the laboratory.

NEW APPARATUS FOR DETERMINING THE COEFFICIENT OF EXPANSION OF GASES

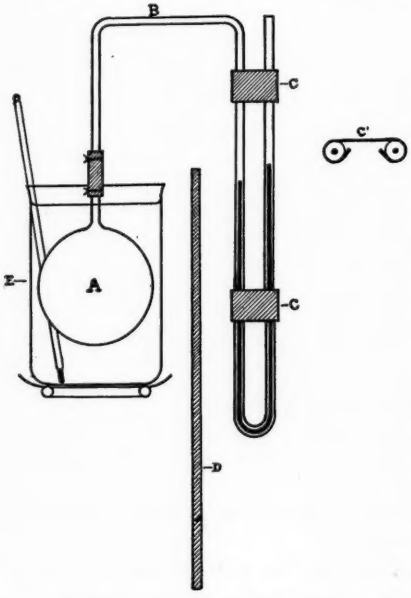
W. H. CHAPIN AND R. N. MAXSON, OBERLIN COLLEGE, OBERLIN, OHIO

Outline of Method.—The pressure of the gas contained in a large bulb is measured at two temperatures by means of a stationary mercury manometer, and the change in pressure per degree is calculated in terms of the pressure at 0°C.

The equation used in the calculation is as follows:

$$P_1 : P_2 :: 1 + t_1x : 1 + t_2x$$

where P_1 and P_2 are the two pressures read at the temperatures t_1 and t_2, respectively, and x is the coefficient of expansion (pressure).



Apparatus.—The apparatus is seen in the sketch herewith. The bulb A is of Pyrex glass and holds 200 cc. These bulbs were made to order by the Wilkens-Anderson Company of Chicago and conform to the following specifications: Diameter 8 cm.; tubulure 3.5 cm. long, outside diam. 7 mm., inside diam. 4 mm.; total weight of bulb to give proper thickness of glass must be between 50 and 60 gm.

The manometer B has a bore of 1 mm. diameter. The two outer arms are 30 cm. long. This is attached to the bulb by means of a connector of pressure tubing, the latter being securely tied in place by means of waxed cord. The manometer and bulb are supported by means of a ring-stand and clamp attached just above the connector.

Before being connected to the manometer the bulb is carefully dried out by heating in an air-bath to 200°C. while conducting into it a slow current of air dried over sulphuric acid. The air current is allowed to continue during the cooling also.

The reading of the manometer is facilitated by means of the tin slides C, which are bent around the arms of the manometer as indicated in C'. They should be tight enough not to slip too easily.

The manometer is protected from the heat of the flame by means of the transit board D.

The beaker E contains water sufficient to cover the bulb completely and this amount must be maintained. The temperature t_1 and t_2 are taken by means of a thermometer standing in this water.

Procedure.—After carefully stirring the water surrounding the bulb take its temperature accurately, and record this as t_1. Also read the barometer. Tap the manometer with a pencil to make sure the mercury is not sticking, adjust the two slides to correspond with the two levels of the mercury, and then measure off the difference in height in millimeters. To find P_1 add this difference to, or subtract it from, the barometric pressure, depending upon whether the pressure inside the bulb is greater or less than that of the atmosphere.

When this is done heat the water to boiling and let it boil for about five minutes. Now again tap the manometer, adjust the slides, and note after another minute whether there is any further rise. If not, measure the difference in levels as before. (The flame may be out in the meantime.) P_2 is calculated just as P_1 was.

The temperature t_2 may be obtained by consulting a table of boiling points for water at different pressures, or it may be read off on the thermometer before the boiling is stopped.

Substitute values now in the equation given above and compute the value for x in decimal form. The correct value is 0.00366. The value here obtained will differ only in the last place. For example, the value might be 0.00371, which varies from the correct value by five in the last place.

Calculation and Results.—The following figures will serve to show how the data may be recorded and the calculation made:

$t_1 = 20°C.$	Barometer	745 mm.
Manometer reading at 20°		−2 mm.
$t_2 = 99°C.$		
Manometer reading at 99°		199 mm.

$P_1 = 745 - 2 = 743$ mm.

$P_2 = 745 + 199 = 944$ mm.

$743 : 944 :: 1 + 20x : 1 + 99x$

$743 + 73557x = 944 + 18880x$

$54677x = 201$

$x = 201 \div 54677 = 0.003677$

The results have been uniformly good. No value has been obtained which varied from the theoretical in the second significant figure; that is, by ten in the third figure. The following table contains all the values but one so far obtained. The one value not recorded was utterly wrong because the student obtaining it failed to keep the bulb covered with water during the determination. Some of these values were obtained by students, who worked without written directions; some were obtained by one of the authors.

	0.00367
	0.00371
	0.00368
	0.00367
	0.00356
	0.00369
Av.	0.00366+

Time Required.—The time required to obtain the data and make the necessary calculation is about forty-five minutes for the first determination, and somewhat less for succeeding ones. After a determination has been made, all that is necessary for beginning the next one is to pour out the hot water and substitute water at room temperature. It is possible, therefore, for a student to obtain as many as five values in one afternoon of three hours and a half. In case of breakage the preparation of new apparatus takes very little time. Indeed, the drying out of the bulb takes most of the time.

Sources of Error.—Five possible sources of error may be considered:

(1) The gas in the manometer tube between the bulb and the mercury may not be heated to the same temperature as the gas in the bulb. The actual volume of this gas is 0.28 cc.—only 0.1 per cent of the total volume. Hence a slight difference in temperature means nothing.

(2) Movement of mercury in the manometer allows an expansion of the gas in the bulb. The mercury moves about 10 cm. Since the diameter of the bore is 1 mm., the cross section is 0.78 sq. mm., and a length of 10 cm. has a volume of 78 cu. mm., or 0.078 cc. Out of a total volume of 200 cc. this amounts to 0.039 per cent.

(3) The bulb expands when heated. The cubical coefficient of expansion of Pyrex glass is 0.0000096. For a temperature difference of 70° the total expansion would be 0.00067, or 0.067 per cent.

(4) Moisture may leak into the bulb through the connector. If moisture did so enter, it would condense to a film on the glass when cold, and would vaporize and increase the volume when heated. This increase in volume would cause an apparent increase in the coefficient of expansion. No such increase has been observed.

(5) An error may be made in reading the temperature t_1 and t_2. This

error need not be allowed if a calibrated thermometer is used. An error might be made if the value for t_2 were taken from a pressure table, and the water should happen to become superheated. But superheating may be avoided.

Apparently the only active sources of error are (2) and (3), both of which allow an expansion of the gas, and so should operate to lower the value for the coefficient. The combined error thus caused would be 0.039 per cent + 0.067 per cent, or a total of 0.16 per cent. This error appears only in the fourth significant figure of the result, and so is outside the recorded values. Moreover, since the error is constant, a correction may be applied, if desired.

THE EFFECT OF THE EQUAL PAY FOR TEACHERS BILL IN NEW YORK STATE*

ERNEST N. PATTEE, SYRACUSE UNIVERSITY, SYRACUSE, N. Y.

In 1924, after a considerable period of agitation, the Legislature of the State of New York passed a bill providing that in all matters relating in any way to salaries in all of the public schools of the state, no discrimination should be made in regard to sex; that is, all teachers doing work of equal grade should receive equal pay.

This bill was strongly opposed on the grounds that it was contrary to sound economic principles and that the salaries of all teachers should be determined by the law of supply and demand; that the bill would place heavy additional financial burdens on the school authorities; that it would prevent the giving of just recognition to teachers of superior ability; and that it would tend to drive the men teachers out of the schools.

In spite of these objections the bill was passed. When the Governor signed the bill he stated that in his opinion no valid reasons had been presented against the rule that women teachers who were doing work of equal grade with men should receive equal salaries.

If in any schools the salaries of the men and women teachers were not equal, the provisions of the law could be complied with by increasing the salaries of the women or by reducing the salaries of the men.

When this law went into effect, in some places a fair effort was made to comply with its provisions. The salaries of the women were increased and this was to be permanent as long as the necessary funds could be provided.

In some cases the salaries of the women were made equal to those of the men but warning was given that the salaries of all teachers would be re-

* Read at the Baltimore Meeting of the A. C. S. before the Division of Chemical Education, April 10, 1925.

duced next year unless a larger amount of money was available, which did not seem probable.

In some cases the authorities said that their schools were crowded and that new buildings were needed; that the classes were too large for efficient instruction that more teachers were needed, and that until these needs were met they could not afford to increase the salaries of the women and hence the salaries of the men must be reduced.

The effect of these conditions is decidedly to discourage good men from entering the teaching profession. Even in those cases where the salaries of the men have not been reduced but the salaries of the women have been increased, the chances for any salary increases for the men are less than formerly as now all teachers must share any increase given. So far as I have been able to learn from teachers, principals, superintendents and agencies, the best men teachers are dissatisfied with the prospect and are looking for positions outside of the state or in those state positions where their salaries will not be reduced.

If the present law stands, what are the school authorities proposing to do to retain the men? In case a man has some athletic ability and can coach the school teams, he will be given the regular salary and such additional sum for his services as coach as may be desired.

Some times the difficulty is met by making a man the head of his department when his salary can be increased, but in smaller schools where the man is the whole department this cannot be done. A man teaching Chemistry may be made Vice Principal or Director of Science Teaching (if he is not the only Science teacher) and hence can be given any salary. Such arrangements are probably legal.

The most serious effort to evade the intent of the law is this. If a woman is teaching English and a man is teaching Chemistry the claim is made that they are not doing work of the same grade and hence the man may be paid a larger salary without any discrimination. Women claim that this view is in direct conflict with the clear intent of the law and if any serious attempt is made to put this plan into effect, the question will be taken to the courts.

A great many believe that the law is a mistake and that it should be repealed, but the question of its repeal is complicated by the fact that if the present law stands and is fairly complied with, a strong effort will be made to extend its provisions to all employees of the state, counties and cities. I do not expect an early repeal of the law.

If the law stands, the State will be asked to assume the entire additional expense caused by the increases in the salaries of the women teachers. This measure will have strong support but it is not clear how it would lighten the burdens of the tax payers.

At present the number of men teachers in the schools in this state is

much too small. Each year the demand for able, well trained men for high-school positions is greater than the supply. It has been said that one of the greatest needs of our schools is for a larger number of capable, well-educated men on the faculties.

If the present law is not repealed and if it is decided that in all departments of a school the work must be considered of equal grade, it seems quite clear that on the whole the salaries of the men teachers will be reduced and the number of men on the school faculties will be diminished.

THE CALCULATION OF THE FORMULA OF A COMPOUND FROM ITS PERCENTAGE COMPOSITION*

JAMES KENDALL, COLUMBIA UNIVERSITY, NEW YORK CITY

The following illustration of the method employed in calculating the formula of a compound from its percentage composition is not strictly scientific, but it has been found, by actual practice, highly successful in capturing the interest of the student and inducing him to keep in mind the successive steps for use in other examples. Every teacher of undergraduates knows that the main difficulty, in a topic like this, is to get the beginner stimulated to the point where he *wants* to remember, and an instance taken from every-day experience is often the only way of making an important theoretical point "mean something" to him.

I made the experiment last year of introducing the calculation of formulas from percentage compositions to my freshman students at Columbia by telling them this story:

New automobile fuels are always being boomed in the newspapers. About once every year some genius discovers that he can add a teaspoonful of a green liquid to five gallons of water and obtain a cheap substitute for gasoline that will revolutionize the industry. Of course he keeps his formula strictly secret, and refuses to go into details, but he generally succeeds in interesting some prominent man (who should know better) in his invention, and gets considerable notoriety before he is exposed as a crook. Well, one day I managed to pocket a small sample of one of these secret formulas during a demonstration, took it home and analyzed it. Its percentage composition ran as follows: Boron 3.61; Uranium 78.82; Nitrogen 4.64; Potassium 12.94.

Now how am I going to get the formula from these figures? The percentage composition represents *weight ratios* of the elements present; to transform these into *atomic ratios* I need to divide each value by the respective atomic weight (see the table below). Having done this, I obtain

* Read before the Ithaca Meeting of the A. C. S. in the Division of Chemical Education, September, 1924.

a series of figures expressing the relative numbers of the various atoms present. I see that, in this particular case, all of the numbers are equal. Therefore the substance contains equal atomic quantities of each element, and its simplest possible (or "empirical") formula is given in the last column.

	Percentage composition	Atomic weight	Atomic ratios	Simplest whole numbers	Empirical formula
Boron	3.61	10.9	0.331	1	B
Uranium	78.82	238.2	0.331	1	U
Nitrogen	4.64	14.0	0.331	1	N
Potassium	12.94	39.1	0.331	1	K

When the class had assimilated this (incidentally, I discovered that various individuals sprang it upon their friends in other sections, a thing they had never done before!) I assigned the following exercise:

While working in his laboratory recently, a chemist discovered that nitric oxide and a mixed sulfide of barium and sodium combined to form a substance with the following percentage composition: Nitrogen 5.71; Oxygen 6.52; Barium 55.97; Sodium 18.75; Sulfur 13.04. Calculate and write down the formula of his discovery. (*Note:* Be careful to retain the above order of elements, and write down any atomic symbol twice if necessary.)

The students who survived this second example (and their sense of humor fortunately proved keen enough to carry them through without a single casualty) never experienced any difficulty at all in working out formulas in subsequent quizzes, however complicated they might be. Under the orthodox method of instruction, on the other hand, a large percentage even of the brighter members repeatedly failed to negotiate such problems, simply because the necessary technique did not interest their minds sufficiently to make any permanent impression.

As I have remarked before: "The human touch is almost indispensable in undergratuate chemistry, and the teacher who scorns to stoop cannot complain if he fails to conquer."

THE PERIODIC LAW

A Bedtime Story for Wide-Awake Children

ELEANOR ERWIN, MILLS COLLEGE, CALIFORNIA

Hattie Hydrogen gave a great big birthday party, and invited all her little friends who lived in the village called Element. Element is a queer place, for no "grown-ups" live there; therefore the inhabitants are all children. These children call themselves "The Elements." All the Elements came to Hattie Hydrogen's party. There was Susy Sulfur, all arrayed in a dress of yellow flowered material. Tommy Tin and Sammy Silver marched about proudly in their new shiny suits. Everybody was happy and excited. Just as the party was about to begin, that is, just as all the children were seated with dishes of ice cream and huge pieces of chocolate cake, the lively Halogen boys rushed in. They were dressed in bright suits of various shades of yellow and brown. When no one could eat one jelly bean more, the dancing began. Charlie Chlorine, one of the Halogen boys, was so lively that it took a great deal of careful watching to keep him from dancing with Hattie, for in that sunny room there certainly would have been an explosion if those two lively youngsters got too near each other. When the tag dances began, Katty Phosphorus and Nancy Sodium got quite boisterous. They stepped on Goldie Gold's toes, knocked Luther Lead over, and tied Mary Mercury's sash to Walter Tungsten's belt. All the Elements got excited and started to chase Katty and Nancy around the room. Hattie Hydrogen tried to make herself heard above the racket, but no one paid any attention to her pleas for silence.

"Stop! stop!" she cried. Just then Oliver Oxygen bumped into poor Hattie. She burst into tears. (Whenever Miss Hydrogen and Master Oxygen get together in heated moments the atmosphere is sure to become damp.) Hattie's tears made the children stop their running about. "Please all sit down. We have to get in order so that we can play the next game," said Hattie, drying her eyes. "There should be seven rows with eight in each row. Line up according to your weights." The Elements did as Hattie told them, and found, when they were lined up in order, that they were in groups, the members of which looked and acted alike. The Halogens were in one group, the lazy slow gases like Harry Helium, Amelia Argon, and the rest of their family were in another group together.

"Oh, Look," said Susy Sulfur, "we are in the same groups with our special chums."

"Yes," answered Hattie, "I knew it would come out that way if you lined up according to your weights."

* Prof. Minnie A. Graham of Mills College, California, writes that this paper was passed in by one of her pupils, Miss Eleanor Erwin, as part of the regular work in answer to a request for a short paper on the Periodic Law.

Just then there was a loud yell, followed by the sounds of a fight. Ira Iodine and Tilly Tellurium were pounding each other and rolling about on the floor. When Hattie finally managed to pull them apart, Tilly's dress was all torn, and there was a scratch across Ira's nose.

"I'm heavier than Ira, so I belong with the Halogens," cried Tilly.

"I don't care, I'm a Halogen, and *won't* go in Susy Sulfur's group!" screamed Ira. "Anyway, even though I do weigh less than Tilly, I bet it's just because she ate six dishes of ice cream, while I only ate three and a half."

"No, Ira, you really are lighter than Tilly, but you may go into the Halogen group, for that's where you belong. There are a few times when the system does not work out."

"Why do you make some of the children move over and leave blank spaces?" asked Susy.

"Those blank spaces are for some Elements which haven't come to this village yet," answered Hattie. "Now, hold still, so we can play this new game." There was a flash of light.

"What's happened!" cried the Elements.

"Nothing, I only took a flashlight picture of you," said Hattie. "Ray Radium lent me some of his 'emanations' for my camera, so I'm sure that with his help the picture ought to turn out beautifully."

"I hope it doesn't turn out an X-Ray picture" said some mischievous Element.

Then the Elements said "Good-bye," and marched home in groups, each boy and girl carrying a bright-colored basket full of nuts and candy.

* * * * * * * * *

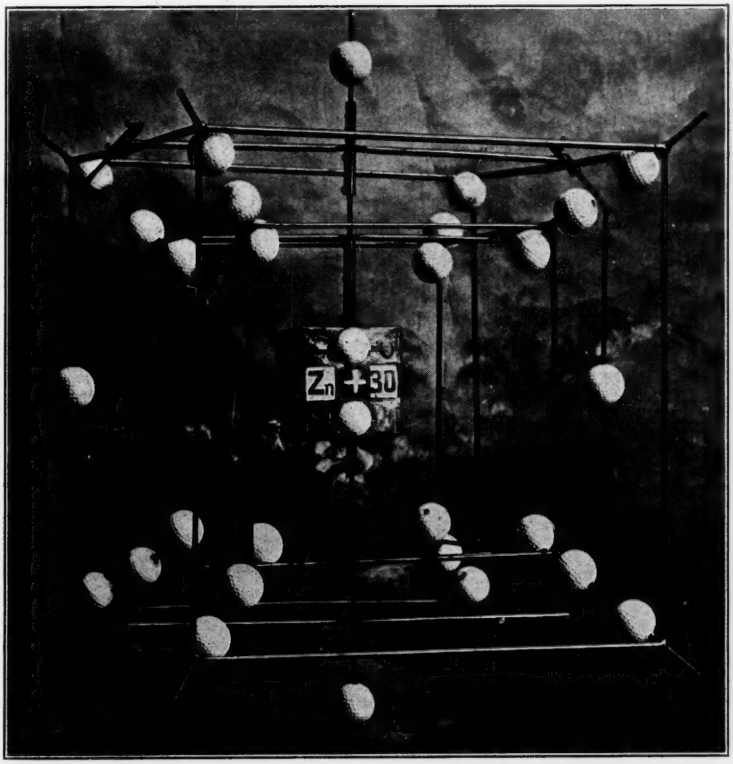
Now, children, I think it is just about time for you to hop into bed, for even the most wide awake of you are beginning to nod. Some day, when you are as old as I am, you will learn more about the arrangement of the Elements. You will hear all about how Mendeleeff and Meyer worked out this arrangement or Periodic System as it is called. You will also learn about Döbereiner's triads. You will learn that the elements in the first group, or rather in Group I, form strong bases, and those in the last group form acids. You will learn that the valence of the elements increases as the number of the group grows larger. You will read about Moseley's atomic numbers. The advantages of this system, namely, that it helps a person who tries to study the elements, and that it helps people discover new elements—all these you will learn. *And*, last of all, you will learn that: "The properties of the elements are periodic functions of their atomic weights (or numbers)."

My, what a chorus of yawns! I guess you are all willing to go to bed after all that.

AN ADJUSTABLE ATOMIC MODEL

G. O. HIGLEY, OHIO WESLEYAN UNIVERSITY, DELAWARE, OHIO

The central positive nucleus is the same for all elements. It is represented by a hemisphere of rubber about three-quarters of an inch in diameter, colored black and bearing a plus sign in white. It is fastened to the center of the front of a sheet metal box 4′ x 4′ x 3′. An opening $1\frac{1}{4}$′



square in the front of the box on each side of the center, permits a view of the symbols and the atomic numbers which are printed in two rows upon a ribbon four inches wide, wound on two cylinders within the box. By turning a milled head, these characters may be caused to move upward past the openings.

The two electrons of the first shell are represented by two hemispheres of rubber about one inch in diameter attached to the front of the box one above and the other below the central nucleus. One of these hemi-

spheres is readily detached; when this is done and the ribbon is set at H, 1, it represents the hydrogen atom. If now the second hemisphere is attached just above the central nucleus, and the ribbon is moved forward to He, 2, there appears a representation of the helium atom.

The vertical axis of the system is made up of two steel rods attached centrally to the front of the top and bottom of the box. The rods are held in place by two brass connectors with two screws each, brazed to the box, above and below.

In order now, to represent the constitution of elements of higher atomic numbers, a second and a third shell are represented as follows: Two cubes 12′ and 18′ in diameter, respectively, are made of steel rods $^3/_{16}$′ in diameter electrically welded at the angles. In order to attach these to the central axis, a rod of proper length is placed across the middle of the top and bottom of each cube parallel to the front edge and welded to the side frame. The center of each rod is flattened and perforated to admit the vertical axis. The central box is placed within the smaller cube, and this again within the larger, with the vertical axis in position: the parts are now so adjusted that the center of the sphere representing the positive nucleus is at the center of the entire system, the cubes being attached to the axis by perforated disks provided with set screws.

At each angle of each cube two steel pins, one inch in length are welded, one on the inner side of the cube, and the other on the outer side, both placed radially. Upon these are placed white balls of solid rubber, one inch in diameter, properly perforated.

In order to represent the structure of atoms in the middle of a long period (cobalt, nickel, zinc, etc.) electrons must also be represented on the vertical axis above or below, or on a rod outside the face of the cube as shown in the figure.

The seventeenth summer session of the School of Chemistry of Middlebury College will run, from June twenty-seven to August fifteen, a special course in the teaching of chemistry. As a new feature it will be given by Dr. H. A. Neville of the University of Illinois and should appeal to all teachers of science whether experienced or not. For further information address Professor P. Conant Voter, Dean of Chemistry School, Middlebury, Vermont.

CLASSROOM EMANATIONS

Hydrofluoric acid itches glass. (Instructor's rejoinder, "Well, isn't it too bad that glass is so hard to scratch!")

The chief use of antimony is in rat poison and cow feed; of calcium carbide is in baking powder; of Hydrochloric Acid is in the manufacture of salt.

An element is anything which occupies space.

Requisitions at the stock room window; alimony, porcelain vestibule, hot bath, periscope, methyl orange juice, brunette with meniscus, iron fillings, hood, set of atomic weights.

To distinguish between $HgCl_2$ and HgCl, feed both carefully to patients. The $HgCl_2$ would have a noticeably toxic effect.

Iron burns more rapidly in oxygen than in air, because pure oxygen is more consecrated than air.

Denatured alcohol is alcohol which has not fermented.

One student claims that soft water contains K, while hard water contains Na; another says that hard water is only ice.

Sodium reacts with water to form Soda Water, NaH_2O, which is a very important "com. lb."

A suspension is a temporary delay.

Gases transfer heat usually by conviction.

A formula is a group of letters that can be broken up into elements.

The fixation of nitrogen is important to man because too much nitrogen would cause death. Man cannot live in pure Nitrogen.

Two common alloys of Zinc are Lead and Tin.

Glass and porcelain can be used as dishes because of their sanity.

Iron occurs chiefly in Minnesota and in the blood.

Readers Views:

One correspondent writes:

"Whenever I see statements of this sort on any of my papers, I try to analyze them to determine how much of the foolish statement is due to lack of care on my part in presenting material. I believe these foolish statements should be a real lesson for a thoughtful teacher." Another says, "Since I believe that laughter is one of mankind's greatest blessings, I urge you to continue the publication of such items." A third ties the score by admitting, "After 25 years of this kind of replies in the classroom, I prefer not to see any more."

Editor's Note: Readers are urged to report any items which they have collected. This page will appear in THIS JOURNAL only when sufficient acceptable material has accumulated.

PRIZE-WINNERS IN THE A. C. S. ESSAY CONTEST FOR 1924–25

ALABAMA

Lane Rhodes, Albertville, Ala.
Ethel Palmer, Hamilton, Ala.
Enid Moses, Hamilton, Ala.

Sidney McInnis, Enterprise, Ala.
Mildred Hearn, Albertville, Ala.
Jane Summers, Ensley, Ala.

ARIZONA

Elizabeth Galbraith, Jerome, Ariz.
Edna R. Woolf, Phoenix, Arix.
Helen Baker, Phoenix, Ariz.

Mildred Fitzgerald, Glendale, Ariz.
Wing F. Ong, Phoenix, Ariz.
Ted Dykes, Phoenix, Ariz.

ARKANSAS

William E. Jones, Little Rock, Ark.
Claud Davis, Marion, Ark.
Edwin Wheeler, Magnolia, Ark.

Victoria Moore, Arkadelphia, Ark.
Annie Grace McClelland, Fayetteville, Ark.
Rebecca Sue Clifton, Russellville, Ark.

CALIFORNIA

Maxine Watkins, Oakland, Calif.
Arthur W. Stuart, Santa Cruz, Calif.
Ruth Jamieson, Whittier, Calif.

Clyde M. Stine, Berkeley, Calif.
Helen Lorraine Miller, Modesto, Calif.
Winona Wilden, Colton, Calif.

COLORADO

Joseph L. Scavotto, Trinidad, Colo.
Ruth Gordon, Colorado Springs, Colo.
Forest Lillie, Colorado Springs, Colo.

Richard Wilder, Denver, Colo.
Nell Stephenson, Colorado Springs, Colo.
Bert Hanna, Nucla, Colo.

CONNECTICUT

William Julianelle, New Haven, Conn.
William Israel Bilevitz, New Haven, Conn.
H. Philip Dudley, Guilford, Conn.

George Hulse, Jr., New Haven, Conn.
J. Bertram Whitelaw, North Stonington, Conn.
William Finkelstein, Waterbury, Conn.

DELAWARE

Oliver W. Eastburn, 3rd, Wilmington, Del.
Norman L. Trott, Dover, Del.
Ralph W. Tyler, Milford, Del.

Howard J. Wood, Wilmington, Del.
Rebecca Hobson, Smyrna, Del.
Carmen Thomaschewski, Wilmington, Del.

DISTRICT OF COLUMBIA

Ida E. George, Washington, D. C.
Alice Antoinette Adams, Washington, D. C.
Mary Farrell, Washington, D. C.

Stephen P. Gerardi, Washington, D. C.
Beulah Caton, Washington, D. C.
Robert Alpher, Washington, D. C.

FLORIDA

Raymond Edmund Ford, Fort Pierce, Fla.
Raphael Francis Hartman, Saint Leo, Fla.
Gladys Powell, Orlando, Fla.

John Francis Hohenthaner, Saint Leo, Fla.
Edith Miller, Eustis, Fla.
Myrtle Hart, Lake Wales, Fla.

GEORGIA

Rembert L. Starr, Macon, Ga.
Harold Clotfelter, Walker Park, Ga.
Luther Ferguson, Walker Park, Ga.

Lillian Cannon, Americus, Ga.
Estelle Kenny, Atlanta, Ga.
Paul Griswold, Atlanta, Ga.

IDAHO

Myrtle Mack, Grangeville, Idaho
Ralphine Ronald, Coeur d'Alene, Idaho
Dorothy Robel, Sandpoint, Idaho

Percy Lantzy, Coeur d'Alene, Idaho
Alma Nelson, Coeur d'Alene, Idaho
H. Leigh Gittens, Pocatello, Idaho

ILLINOIS

E. Harold Leland, Oak Park, Ill.
Alfred Petchaft, Carmi, Ill.
Jesse Worley Wilson, Heyworth, Ill.

Lawrence J. Smith, Oak Park, Ill.
Gladys Towle, Chicago, Ill.
Robert W. Hicks, Hinsdale, Ill.

INDIANA

Dwight Shaffer, New Castle, Ind.
Mildred Batz, Rochester, Ind.
Esther A. Compton, Wabash, Ind.

John DeWees, Hartford City, Ind.
Leota Elliott, Campbellsburg, Ind.
Ralph Polk, Jr., Culver, Ind.

IOWA

Catherine R. Miller, Cherokee, Ia.
Mindred Keairnes, Missouri Valley, Ia.
Julian A. Graves, Le Mars, Ia.

Harold E. Thatcher, Sioux City, Ia.
Marion Honke, Carroll, Ia.
William H. Johnsen, Burlington, Ia.

KANSAS

Maysel Archer, El Dorado, Kans.
Jesse W. Young, Kansas City, Kans.
Henry C. Wagner, Lawrence, Kans.

Raymond Morrow, Wellington, Kans.
Della Mae Allen, Wichita, Kans.
Elliot Benson, Fort Scott, Kans.

KENTUCKY

Lillian Rorison Colvin, Louisville, Ky.
Sabra Catherine Walker, Stanford, Ky.
Gray Williams, Berea, Ky.

Frank P. Tunks, Hopkinsville, Ky.
Elizabeth Keith, Louisville, Ky.
Anne Guerrant Green, Louisville, Ky.

LOUISIANA

Shirley Cordill, New Orleans, La.
Virginia Aronson, New Orleans, La.
Mildred Bond, Lecompte, La.
Earhart S. Lobrano, New Orleans, La.
Iva May Dowling, Ruston, La.
William Whipple, Jr., Brusley, La.

MAINE

Percy W. Blaisdell, Kent's Hill, Maine
Edward Gilman Kelley, Orono, Maine
Edgar B. McKay, Winslow, Maine
Paul A. Roy, Lewiston, Maine
Elinor Stimson, Gorham, Maine
Eugene Roy Millett, Kent's Hill, Maine

MARYLAND

W. Grafton Hersperger, Baltimore, Md.
Stanley L. Cahn, Baltimore, Md.
Joseph C. Long, Denton, Md.
Katherine Archer, Street, Md.
Chester L. Chaires, Baltimore, Md.
Rosamond Gardner, Baltimore, Md.

MASSACHUSETTS

Salvador Jacobs, Haverhill, Mass.
Mary Bresnahan, Holyoke, Mass.
Morrill K. Hall, South Braintree, Mass.
Roger S. Makepeace, Andover, Mass.
Clintina Wright, Agawam, Mass.
Robert A. Pratt, Deerfield, Mass.

MICHIGAN

Wendel A. Mahaffy, Ann Arbor, Mich.
Hazel E. Grover, Detroit, Mich.
Nicholas H. Fritz, Manistee, Mich.
Eva L. Clark, Cadillac, Mich.
Agnes Mauer, Kalamazoo, Mich.
Gwladys Lewis, Detroit, Mich.

MINNESOTA

Florence Vincent, Minneapolis, Minn.
Elsie Baremore, Forest Lake, Minn.
Lawrence A. O'Leary, Barnesville, Minn.
John Russell Juten, Gilbert, Minn.
Irma Jones, Mankato, Minn.
Thomas P. Mortensen, Askov, Minn.

MISSISSIPPI

John Curtis Herbert, Jr., Starkville, Miss.
Audrey Hamilton, Gulfport, Miss.
Harley Burford, Weir, Miss.
Meredith C. Schaff, Vicksburg, Miss.
Mary Turner, McComb, Miss.
Catherine Naomi McFarlane, Aberdeen, Miss.

MISSOURI

Richard Holliday, St. Louis, Mo.
Philip Pascal Smith, Marshall, Mo.
Leonard Hudson, Springfield, Mo.
Irvin W. Streng, Kansas City, Mo.
Georgiana Reedy, Eolia, Mo.
Melvin Wickens, Kansas City, Mo.

MONTANA

Peter R. Lackner, Butte, Mont.
Rose Brutto, Missoula, Mont.
Dorothy Louisa Tway, Great Falls, Mont.
Edna McDonald, Philipsburg, Mont.
Helen Bruneau, Great Falls, Mont.
Wilda May O'Neil, Kalispell, Mont.

NEBRASKA

Oi Greene, Gothenburg, Neb.
Helen Reagor, Kearney, Neb.
Don Peaker, Kearney, Neb.
Neil W. Callam, Pawnee City, Neb.
Ramona Pierce, Gothenburg, Neb.
Harold Turner, Pawnee City, Neb.

NEVADA

Dan Senseney, Reno, Nev.
Dale D. Lamb, Reno, Nev.
Mark Menke, Reno, Nev.
Morris Arthur Newcomb, Reno, Nev.
Rena Smith, Reno, Nev.
Joe Canell, Carson City, Nev.

NEW HAMPSHIRE

William A. Dunne, Manchester, N. H.
Albert Lazure, Berlin, N. H.
Randall Stratton, Exeter, N. H.
* Richard S. Roberts, Exeter, N. H.
* Hugh Kelsea Moore, Jr., Berlin, N. H.
Frank R. Stocker, Exeter, N. H.
John B. Titcomb, Exeter, N. H.

NEW JERSEY

Joseph B. Lombardo, Phillipsburg, N. J.
F. Marjorie Darling, Collingswood, N. J.
H. Howard Bennett, Paulsboro, N. J.
Howard S. Gardner, Jr., East Orange, N. J.
Francis Cosgrove, Trenton, N. J.
Edward A. Green, New Brunswick, N. J.

NEW MEXICO

Helen E. Jenkins, Raton, N. Mex.
Helen Snipes, Roswell, N. Mex.
Ray Eldon Newcomer, E. Las Vegas, N. Mex.
Walter B. McFarland, E. Las Vegas, N. Mex.
Bessie Hart, E. Las Vegas, N. Mex.
Lloyd F. Kniffin, Silver City, N. Mex.

NEW YORK

Aaron Spector, Brooklyn, N. Y.
Louise I. Herrick, Sherrill, N. Y.
Gerald F. Otto, Rochester, N. Y.
Caryl Parker Haskins, Albany, N. Y.
Cornelia Burwell, Lake Grove, N. Y.
Alfred H. Taylor, 3rd, Pearl River, N. Y.

NORTH CAROLINA

David H. Wilcox, Jr., Winston-Salem, N. C.
John Robert Williams, Asheville, N. C.
Thomas Hayes Fawcett, Asheville, N. C.
Winston Smith, Asheville, N. C.
Josiah Evans Hull, Washington, N. C.
Marion Rosalind Green, Asheville, N. C.

NORTH DAKOTA

Ruby C. Sambuc, Sharon, N. Dak.
William Bartley Shanley, Cando, N. Dak.
Leal Edmunds, Grand Forks, N. Dak.
Gail Ellison, Minot, N. Dak.
Cameron Kay, Grand Forks, N. Dak.
Bertha Lien, Fargo, N. Dak.

* Tied

OHIO

Helen I. Hall, Circleville, Ohio
Leonard Wise, Springfield, Ohio
Mary Seger, Toledo, Ohio
Glenn Cole, Niles, Ohio
Carl Meininger, Cleveland, Ohio
Maurice Bernard Schramm, Cleveland, Ohio

OKLAHOMA

Elbert Akin, Okemah, Okla.
Boyd Forbes, Guthrie, Okla.
Margaret Robinson, Tulsa, Okla.
Calvin Brous, Oklahoma City, Okla.
Ruth Hillis, Oklahoma City, Okla.
Helen Burris, Tulsa, Okla.

OREGON

Dorothy M. Baker, Salem, Ore.
Neltje E. Tibbits, Salem, Ore.
Douglas Kirk, Portland, Ore.
Clare Hume, Molalla, Ore.
Evelyn M. Meyer, Portland, Ore.
Garnie Cranor, West Linn, Ore.

PENNSYLVANIA

* John Giovannini, Barnesboro, Pa.
Marion Hardie Raney, Philadelphia, Pa.
Mary E. Clancy, Pittsburgh, Pa.
George Friedman, Easton, Pa.
Florence A. Miller, Philadelphia, Pa.
Frederick Kenneth Saxman, Latrobe, Pa.

RHODE ISLAND

Steward L. Cushman, Pawtucket, R. I.
Kazimierz Zurawski, Providence, R. I.
John W. Barden, Providence, R. I.
Thomas A. Christensen, Newport, R. I.
Catherine McCabe, Westcott, R. I.
Walter M. Fenton, Woonsocket, R. I.

SOUTH CAROLINA

Ruth Jones, Greenville, S. C.
Mabel Scruggs, Columbia, S. C.
Ralph McKinney, Easley, S. C.
Claribel Parham, Charleston, S. C.
J. C. Suber, Greenwood, S. C.
Jack Heath, Greenville, S. C.

SOUTH DAKOTA

* Godfrey Arpin, Clark, S. Dak.
* Marion Pierson, Frederick, S. Dak.
J. Ellison Glattly, Hot Springs, S. Dak.
Glenn Rietz, Sioux Falls, S. Dak.
Ray McAlpine, Clark, S. Dak.
Freda Blum, Huron, S. Dak.
Donald Dickey, Frederick, S. Dak.

TENNESSEE

Mary H. Young, Chattanooga, Tenn.
Pearl Hite, Athens, Tenn.
Frank Lovell, Birchwood, Tenn.
Thomas Duncan, Knoxville, Tenn.
Earl Bagby, Chattanooga, Tenn.
Trimble Sharber, Nashville, Tenn.

TEXAS

Helen Starkey, Harlingen, Tex.
Henry Shipworth Singletary, Jr., Port Arthur, Tex.
Carrol Lee Thompson, Harlingen, Tex.
Dorothy Hackett, Houston, Tex.
Pauline Anna Goldbaum, Dallas, Tex.
Richard Roberts, Amarillo, Tex.

UTAH

Gwenever Anderson, Grantsville, Utah
Thelma L. Jones, Ogden, Utah
Herbert Judson, Salt Lake City, Utah
Lloyd N. Bowen, Ogden, Utah
Maurice J. Miles, St. George, Utah
Worden Robinson, Salt Lake City, Utah

VERMONT

Paul O'Connor, Bellows Falls, Vt.
Clayton Marvin Crothers, Randolph, Vt.
Howard Ryan, Burlington, Vt.
Vernon Bombard, Burlington, Vt.
George S. Crandall, Woodstock, Vt.
Alice E. Stoddard, Bellows Falls, Vt.

VIRGINIA

Murrell Edward Baker, Lynchburg, Va.
Jean Shannon Francis, White Gate, Va.
Thaddeus Morawski, Richmond, Va.
Louis Aronow, Newport News, Va.
Alma Virginia Bolton, Lynchburg, Va.
Lewis C. Mattison, Lynchburg, Va.

WASHINGTON

Everett L. Ticknor, Centralia, Wash.
Julia Bouck, Monroe, Wash.
Malcolm Brown, Sumas, Wash.
Albert C. DeWald, Two Rivers, Wash.
Bethene Burch, Spokane, Wash.
Anna V. Ott, Port Angeles, Wash.

WEST VIRGINIA

Lilian Opie Cook, Huntington, W. Va.
Wandall Rupert Marks, Huntington, W. Va.
Robert G. Elliott, Clay, W. Va.
Henrietta H. Brannon, Weston, W. Va.
Mildred Mettong, Adamston, W. Va.
Robert Witschey, New Martinsville, W. Va.

WISCONSIN

Lucelle Cuthbert, Barron, Wis.
Caroline Kansier, Green Bay, Wis.
Roger Altpeter, Baraboo, Wis.
Sam Weiner, Milwaukee, Wis.
Josephine Bassett, Baraboo, Wis.
Helen Buben, Milwaukee, Wis.

WYOMING

Leslie Baker, Kemmerer, Wyo.
Norman Hansen, Casper, Wyo.
Forest Crawford, Powell, Wyo.
Margaret Whittington, Cheyenne, Wyo.
Barbara Walters, Rock Springs, Wyo.
Mildred Mosby, Kemmerer, Wyo.

EXTRA TERRITORIAL POSSESSIONS OF THE UNITED STATES

Ariosto H. Correa, Arecibo, Porto Rico
Flora Walker, Honolulu, Hawaii
Sadayasu Mitoichi, Papaikou, Hawaii
Kam Hu Lau, Honolulu, Hawaii
Blanca Rivera, Mayaguez, Porto Rico
Ruth Winsted, Honolulu, Hawaii

* Tied

Chemical Digest

ABSTRACTS

Report on Evaluation of Objectives in Chemistry by Teachers in Cleveland, Ohio, Schools and Information Test of Pupils. C. H. SALTER. *Sch. Sci. Math.*, **25**, 467–74 (May, 1925).—The investigation was conducted under the auspices of the Schoolmasters Club of Cleveland. The conclusions are: 1. A lack of agreement as to main objectives of chemistry learning. 2. Chemistry should be taught in the later years of high-school course. 3. Teachers are efficient in preparing pupils for college. 4. A lack of uniformity of teaching methods. 5. Teachers are failing to familiarize their pupils with useful every-day knowledge. 6. A disagreement between the student's idea of the usefulness and his knowledge of particular terms. 7. Shows that the more extensive a person's knowledge in the general field of science, the greater is his knowledge in any particular field of science. H. R. SMITH

Education—The British Association of Chemists. ANON. *Chemical Age* (Lond.), **12**, 456 (May, 1925).—The Association does not view with sympathy any form of chemical training that does not demand of the candidate a high standard of theoretical and practical knowledge, and its scrutiny of the qualifications of those who do not hold a degree or diploma in chemistry becomes always more stringent. It realizes, however, since no formal definition of qualification exists, that recognition only of those who are academically qualified is impracticable.

The old method of apprenticeship is becoming less common. Such a form of training should be supplementary to academic training, but in the past it has frequently replaced it, with results that in many cases have proved far from satisfactory. The Association is in favor of the student's obtaining experience under works conditions, but any form of training exclusively practical is, in its opinion, completely indefensible.

The whole question of the chemist's education is one which requires a searching review. At present the large majority academically qualify before any attempt is made to earn a livelihood, but there are still appreciable numbers who enter works at an early age and gradually, in some cases more or less automatically, rise to positions of responsibility. However justifiable and sound this procedure may have been in the past, its failure to meet the needs of modern industrial methods is now every day more apparent. B.

Hydrogen Sulfide Gas; a Convenient Method for the Generation of Same. ABRAHAM HENWOOD, RAYMOND M. GAREY, WOOLF GOLDBERG, ELMER FIELD. *J. Frank. Inst.*, **199**, 5, 685 (May, 1925).—Utilizing the reaction of sulphur on paraffin wax, first proposed by J. S. Galletley, *Chem. News*, **24**, 162 (1871), the authors have devised a convenient mode of generating H_2S gas. Sulfur and paraffin in the proportion required by the equation $CnH2n + 2 + (n + 1)S \longrightarrow (n + 1)H_2S + nC$ are used and incorporated with dry finely divided asbestos. The material thus prepared has the appearance and physical texture of asbestos. Placed in a small test tube over a small Bunsen flame about one inch high causes the evolution of a copious stream of pure H_2S. The evolution ceases within one minute after withdrawal of the flame. A charge of about 10 cc. volume yields 2000 cc. H_2S. In teaching qualitative analysis each student with such a generator on his table has an ample supply of H_2S at his instant disposal. The air of the laboratory is not contaminated, and the residue is a dry friable mass easily removed from the tube with none of the usual grit and spent acid to dispose of. Alkaline sulfide can be made *in situ* so that ammonium and sodium sulfides need not be provided. J. HOWARD GRAHAM

Design of a Chemical Research Laboratory. CECIL HOLLINS. *Chem. Age* (Lond.), **12**, 394–6 (April, 1925).—"Continuous and concentrated research" is not a luxury, but is a living part of certain industries. The average research chemist must be provided with good tools, a good workshop and efficient direction. The laboratory should be spacious, well lighted and ventilated; if not in a separate building, then on the top floor. If there are skylights, considerable wall space may be used for shelving. White glazed tile makes the best interior finish. Individual laboratories are not efficient, a group of five chemists being of more value to the firm than five individual chemists. With free interchange of ideas, "all the results will be higher than the average level of ability

amongst the five." A laboratory accommodating a larger number is unwieldy. Allow 80 ft. floor space per chemist. Proper ventilation is as difficult as it is important. To reduce drafts to a minimum, definite outlets and inlets for air circulation are necessary. Incoming fresh air should be admitted about 5 ft. from the floor and directed upward. Steam heat is best. Floors should be made of some elastic material which may be moulded up to the walls and benches to facilitate cleaning. The simple flat-topped bench is best, free from permanent fixtures above or on its surface. Each chemist should have space 10–12 ft. long and $4\frac{1}{2}$ ft. wide—at a height of about 3 ft. Hard wood or lead tops are sufficient—with a central channel draining into sink at one end. On every bench there should be a steam jet, outlets for hot water, cold water, gas and vacuum; compressed air is less essential. In America it is customary to have several small hoods on each bench; in England one large hood suffices for the whole laboratory. Drying ovens may well take the form of a combined waterstill and steam oven, with constant level attachment to prevent boiling dry. This should be supplemented by smaller electric drying ovens. A convenient hot sand bath consists of a metal tray 6′ x 3′ with a 2″ layer of sand heated by steam pipes. There should be one or more blow pipes on separate small tables with lead covered tops; a centrifuge for filtration; also separate benches equipped for mechanical stirring and shaking. Balances are most important—it is not advisable to try to economize here. Each bench should have an open balance accurate to 0.1 gm., while a special balance room should contain the finer balances, each supported on a brick pillar built up from a solid foundation. (H. considers Bunge, Sartorius and Oertling balances best.) There should be a separate room for combustion furnaces—with one man detailed for this work. "A semi-qualified man who devotes his whole time to combustions will get results which are much more reliable than those obtained by a chemist who only does a combustion now and then." A special laboratory should be provided for continuous use of H_2S and similar gases. There should also be a separate writing room containing a desk and bookshelf for each chemist.

BAKER

Experiments with Explosive Gas Mixtures. PROF. OTTO OHMANN. *Z. physik. chem. Unterricht.*, **38**, 78–83 (April, 1925).—Experiments with explosives are peculiarly adapted to lead the student deeper into thermo-chemical considerations. The industrial importance of nitroglycerin, blasting gelatine, gun cotton, ammonium nitrate, potassium chlorate, liquid air and the internal combustion engine alone would warrant their study, but they are also worth while from a pedagogical standpoint.

The following list is a compilation of old and new experiments.

1. To measure gas pressure a simple manometer may be constructed from ordinary glass tubing by the student. The U tube is filled with colored water to a convenient height. Excess pressure due to adjusting the rubber tube may be equalized by running a thin knitting needle dipped in talc, between the rubber and glass.

2. Whenever one gas is exploded with another, known volumes should be used, otherwise chance variations cause trouble. For example, a 1325 cc. thick walled cylinder containing 200–270 cc. of illuminating gas, gave a loud explosion, while with 150 cc. of gas as well as 356 cc. there was only a small explosion. The optimum quantity of gas was found to be $\frac{1}{5}$–$\frac{1}{8}$ of the total volume of air-gas mixture. The gas should be collected by displacement of water and the mixture is best ignited with a hot wire or electric spark.

3. Explosion of automatic mixtures of illuminating gas and air. A Woulff bottle is not nearly as good as the top compartment of a Kipp generator (*Z. physik. chem. Unterricht*, **37**, 258 (1925)). This may be held in the hand during the explosion or it may be supported by means of two rings, with the long tip uppermost. The top opening is closed with a cork while a piece of asbestos paper is held loosely across the bottom. After having completely filled the vessel with gas it is lighted at the top. A delayed explosion takes place. The experiment is more effective if performed in a darkened room; the glow gives evidence of the exothermic nature of the action while the noise is entirely secondary. By placing in the neck a plug of steel wool, the explosion is prevented although the mixture burns readily at the plug. (Danger of cracking the glass!)

The above experiment may be adapted for student use by taking a medium-sized funnel with the top cut off straight and closed with a cork. The funnel is inverted over a piece of asbestos paper and held in place by a ring. (The ring *must not* touch the funnel!) At one edge of the asbestos paper a notch is cut for an elbow tube which introduces the gas. Finally remove the elbow tube and light at the top.

4. Hydrogen and air or oxygen.

Two dry cylinders containing O_2 and H_2, respectively, are inverted with their mouths together. The explosion is started by means of a hot wire inserted between the cylinders. Detonating mixture is best prepared electrolytically.

O. describes the common experiment with soap bubble froth, and refers to methods of determining the combining proportions of O_2 and H_2.

5. Cl_2 and H_2, Cl_2 and C_2H_2 or C_2H_2 and O_2 can be exploded as in 4. (Never use a glass vessel for the C_2, H_2 and O_2!) BAKER

Elements of Glass Blowing and Demonstrations. WARREN C. JOHNSON. *Rep. New England Assoc. Chem. Teachers*, **26**, 89–92 (April, 1925).—Some of the properties of glass and facts concerning its manipulation are discussed, as an aid in acquiring the technique of elementary glass blowing.

The four general varieties of glass are soda, lead, Pyrex and quartz. Lead glass is softer and more readily fusible than the soda glass. Pyrex, a boro-silicate glass, must be heated to a higher temperature. Quartz requires exceedingly high temperatures for manipulation.

It is possible to seal two glasses together if their coefficients of expansion do not differ by more than 1×10^{-6}. Ordinary glasses differ by a value too great for successful heating. Quartz has a low coefficient, about 0.5×10^{-6}. Pyrex has the value of 3.3×10^{-6}; soda glass varies from 5.0 to 10×10^{-6}; lead glass 9.0×10^{-6} (about that of platinum).

An unpleasant property of glass is devitrification. If old glass is heated to the fusion temperature a crystallized ring is left at the edge of the portion heated. Glasses with a high SiO_2 content show this property markedly. Most likely some constituent in excess of the solubility limit separates out in the crystalline state. After soda glass has been in store for a year, it is practically useless for good glass blowing.

Unless glass is properly annealed it may crack. After a seal is completed it should be reheated to a point below the softening point and kept in the flame for several minutes, reducing the temperature to that of the smoky flame. It is desirable to wrap the seal in cotton and allow cooling to take place slowly.

The following operations are quite sufficient for ordinary laboratory work: (1) The cutting of tubing. (2) The bending and constricting of tubing. (3) The joining of two tubes of the same or of different diameters. (4) The making of a tee tube. (5) Sealing a tube through another tube. E. G. VAN DEN BOSCHE

Pioneering in the Chemistry of Microbes. ARTHUR J. KENDALL. *Chem. Bull.*, **12**, 131 (1925).—That bacteria are "living chemical reagents" as once described by Professor Folin is yet to be proven. Their influence, however, upon conditions determined by environment is very generally recognized. "The application of sound bacteriological principles 'to such processes as retting of flax, manufacture of glycerin, fermentation of tobacco, and the production of certain alcohols and acids and even certain steps in tanning of leather and the manufacture of synthetic rubber,' is found to be of the utmost importance in securing the best possible yields.** Bacterial processes are, or may be, very economical processes for the reagent perpetuates and vastly multiplies itself."

In explanation of this, it is suggested that "comparatively little material enters into the substance of a microbe, the great disproportion between surface area and volume of the organism requires a comparatively great amount of energy to maintain it.** The cost price is the structural phase which is very modest. The return** is the energy phase, this is, or may be, extremely generous."

From the standpoint of chemistry, "if the microbes are carefully chosen, and their environmental conditions properly adjusted, these self-perpetuating ergogens become available to drive chemical reactions in almost any desired direction."

Another phase of bacterial chemistry that holds a challenge to both chemist and bacteriologist is the mutual relationship of bacterial and the stereo-configuration of carbohydrates. There seems to be a relationship between the asymmetry of living protoplasm and its ability to utilize certain of the configurative compounds.

The writer also finds an urge in the thought that in the microbe "which is merely a colloidal matrix enclosing chemical families which by utilizing organic substances for energy, reproduce their hereditary chemical architecture from suitable nitrogenous compounds," there may be locked the secret which would reveal the difference between "the quick and the dead." There is a thrill in the thought that "some genius will sooner or later compound a 'bioid' from relatively simple ingredients which shall be able to do two things," assimilate and reproduce. "This (in essence), is life, even though reduced to its lowest terms." B. CLIFFORD HENDRICKS

The Results of the Application of Science in the Field of Medicine. T. A. JOHNSON. *Sch. Sci. Math.*, **25**, 457–61 (May, 1925).—Scientific medicine has advanced more in the last fifty years than the arts of communication, navigation and transportation. The average length of human life in the 16th century was between 18 and 20 years. The first of last century it was under 25, in 1870 it was 41, and today it is 56 in U. S., 60 in New Zealand, and 24 in India. If the knowledge of preventive medicine we now

possess could be efficiently applied, the average length of man's life could be extended at least ten years, and his industrial efficiency increased in proportion. Typhoid fever, yellow fever, and small pox have been reduced to almost negligible factors. Diphtheria and scarlet fever are being brought under control. H. R. SMITH

Recent Developments in the Nitrogen-Fixation Industry. (Editorial.) *Nature*, **115**, 465–6(1925).—The production of synthetic ammonia by the Germans was perhaps the greatest material factor in prolonging the Great War. The present annual production of fixed nitrogen is about 500,000 metric tons, three-fourths of which is produced by Germany. The arc process is, as a rule, too expensive, so the annual production by this process is only 36,000 metric tons. Oxygen-enriched air, which has been used principally in Germany and Switzerland, has led to some serious explosions; therefore other methods have displaced this process. The outlook for the calcium cyanamide process is not so promising as it might be, for cyanamide has not come up to expectations as a fertilizer. Furthermore, the power requirement for its production is much greater than that of the direct synthetic-ammonia process. The annual production is about 140,000 metric tons, about one-half of the world's plant capacity being utilized. Calcium cyanamide may be used as an intermediate product in the manufacture of urea, which appears to be the nitrogenous fertilizer of the future. Urea will probably be produced by combining ammonia with carbon dioxide at high pressures and temperatures. The Haber process furnishes about 65 per cent of the world's production of ammonia by nitrogen-fixation. It is likely that the DuPont Company will make the Bucher process a commercial success. This company uses producer-gas and a mixture of carbon black and soda ash (plus catalyst) obtained by evaporating to dryness the "black liquor" which results from boiling wood with sodium hydroxide in the manufacture of wood pulp, and by heating the residue, air being excluded, to 250–350°C.. 60–65 per cent of soda ash and 40–35 per cent of carbon is obtained. The yield of cyanide at this stage is 50–55 per cent. After leaching, sodium cyanide is obtained by crystallization. By hydrolysis of the cyanide, ammonia is obtained. WILLIAM FOSTER

Fading of Dyed Materials. *Dyestuffs*, **26**, 45–7 (April, 1925).—The problem of explaining the cause of color fading is extremely complicated, and various theories have been advanced, *e. g.*, oxidation, reduction, enzymes, moisture. No one reason can be put forth as being always the cause of fading, as must be apparent from the difference in the degree of fastness of colors on wool as compared with cotton, or the good properties of dyes when exposed on glass to the atmosphere and sunlight as compared to their behavior when dyed on some material. The type of light to which dyes are exposed is important. In some cases colors "go" on exposure to direct sunlight and return partly in diffused daylight. Indigo suffers somewhat in direct sunlight, and after being kept in the dark sometime returns to its original state.

"It is those rays of light which are adsorbed by the dyestuff which are the cause of the reactions occurring when the color fades. If those rays are not present the color does not fade. The light itself is not the cause of fading, but the rays may set up intramolecular vibrations in the dye, with the loosening of certain valences producing greater reactivity." Malachite green can be decolorized by arc light, and regains its color in sunlight.

"If a dyestuff is fast to light its molecule must be capable of absorbing light waves of large amplitude and of being set in a strong vibration by this adsorption without destructive action." This is the case in large symmetrical molecules having no reactive side chains. "The fact that only the adsorbed rays can produce chemical reaction shows that it is the disturbance of the electrons by light which produces chemical reactions."

D. C. LICHTENWALNER

Speeds of Atomic Particles. A. T. MERRICK. *Sci. Am.*, **81**, 301 (May, 1925).—Graphic representations of the speed of a rifle projectile (2800 ft./sec.), the steam locomotive (104 ft./sec.), automobile (158 ft./sec.), aeroplane (300 ft./sec.), the earths orbital speed (97,680 ft./sec.) the orbital speed of the hydrogen electron (1300 miles/sec.) and the orbital speed of an electron in the uranium atom (125,000 miles/sec.).

"The energies of motion in a collision at full speed between two 100-ton locomotives and in the atoms of a half a glass of water are equal. The hydrogen electron makes as many revolutions in one second as does an aeroplane propeller in 4,000,000 years." B.

Chance in Experimenting. H. GERNSBACK. *The Experimenter* **4**, 439 (May, 1925).—The author points out that in experimental work, chance happenings are frequently the most important. Copious notes should be made of these unforseen and unexpected results, since on subsequent review they may offer valuable suggestions. Several incidents in which chance discoveries led to important results are cited, *viz;* the work of Bell, Daguerre and Thompson. D. C. L.

Aluminum Paint for Oil Tanks. *Science Service.*—The Oklahoma and Federal

Bureau of Mines found that a tank covered with aluminum paint or white paint rose in temperature when subjected to a given intensity of light only 19 to 22 degrees: but if the tank was painted dark blue or dark green, the increase in temperature was 35 to 40 degrees; and if the tank was painted black it increased in temperature by 54 degrees.

The loss of the oils which filled these tanks was very different. During a short period the black-painted tanks lost 9 per cent of their naphtha content, whereas the white-painted tanks under the same conditions lost only 4 per cent. Some tests were made on big tanks containing 55,000 barrels of crude oil each. In this case the evaporation loss was more than 50 per cent greater in the black tank than in the one painted with aluminum paint.

The results of these tests indicate the importance of light colored paint for storage tanks containing oils or other compounds which may be lost by evaporation at slightly elevated temperatures. This is sufficiently important that some of the petroleum companies have already adopted the custom of giving their gasoline storage tanks a fresh coat of light colored paint each year. The saving from evaporation more than pays the cost of the frequent painting. B.

Pure Silvery Aluminum. *Science Service.*—Pure aluminum will now be available in commercial quantities through the development of the "Hoopes" refining process in which the aluminum is separated from the fused salts of sodium, aluminum and barium fluoride by electrolysis. Previously the highest grade product contained 99.7% aluminum, the chief impurity being copper. Now a product 99.98% pure is obtained. In ordinary kitchen utensils iron and silicon are the chief impurities, which produce a grayish purple color and cause the metal to loose its luster on exposure. This pure aluminum has a silvery color and retains its luster very well. D. C. L.

Artificial Food. EDWIN E. SLOSSON. *Science Service.*—"Will man ever be able to manufacture his own food? Must be always be independent upon plants for his provender?" The five essentials named in the order in which the chemist is conquering them are, salts, fats, carbohydrates, proteins, vitamins. The first is simple. Fats can be made artificially, but the process is tedious and expensive. New light has recently been thrown on carbohydrate formation; Dr. Baly has shown that a sirup containing about 10% glucose can be prepared from formaldehyde on exposure to ultra-violet light, but the energy expenditure is enormous. Proteins due to their complex structure offer more difficulties, but the amino acids which go to make up their structure can be prepared synthetically. Our knowledge of vitamins is still quite limited, but the recent discovery of the activation of food by ultra-violet rays gives promise of ultimate victory. "Three of the five food products could theoretically be made in the laboratory, though it may be some time before we make enough of the third to feed a rat. The fourth seems possible and the fifth looks hopeful," so that both questions can be answered "yes." D. C. L.

Playing the Game in the College Classroom. H. H. HIGBIE. *The Wiley Bulletin.* May, **1925,** 1, 3.—The fact that many college teachers still attempt to instruct by the formula method is lamented. The usual methods of conducting classes in colleges have generally failed to arouse the active intellectual interest and initiative of the average student.

The spirit of contest should be developed! A quiz is like an obstacle race. One question should be so easy that everyone can answer it, and one so difficult that the best student cannot get a perfect mark; the remainder of the questions fall between these two extremes. In grading, the student's mark is recorded as the ratio of his grade to the highest actually received by anyone in the class. In this way there is always one grade of 100%, and the rest are scattered between this and zero. Under this system the grade truly represents a student's ability in comparison with his fellow competitors.

The value of constant tests is stressed. Every session of the class should involve three processes: A giving of advance material by the teacher, a discussion by the class with its instructor of the difficulties it is having, and a test of the class by the instructor.

C. E. WHITE

The Place of Religion in Higher Education. C. A. RICHMOND. *Bull. Am. Assoc, Univ. Professors,* **11,** 172 (1925).—"We have been forward in teaching sciences but we have been very derelict in getting to our students any adequate comprehension of just the relationship of the whole scientific field to some of the deep issues of life. During these years we have been saying that the issue between science and religion was settled fifty years ago, and now we awake to discover that the rank and file of the American people have no real comprehension of what science is, or what science is teaching. Now, indeed, it is a curious situation in which we find ourselves. You and I have lived through a marvelous transition in thought, and I sometimes wonder that we have done as well as we have, when I think of what you and I, for example, were taught along re-

ligious lines, and what we believe now." Some contrasts along this line are shown in: "Christ is no longer the center of metaphysical discussion about His person, but all of our thoughts, political, commercial and economic, are increasingly Christlike. Man is no longer the wreck and ruin of a once perfect harmony, but he is a chaos, not yet reduced to order. Sin is not merely a taint of the past, but selfishness, pure and simple.***All things are not true, because they are in the Bible, but they are in the Bible because they are true. Now these represent tremendous shiftings; they do not represent any loss of religious conviction; but how much have you and I done to see to it that college men and women know even this much." B. CLIFFORD HENDRICKS

The Articulation of General Science with the Special Sciences. W. R. LEKER. *Gen. Sci. Quarterly*, 9, 3, 158 (March, 1925).—The aim of a course in general science is the promotion of an understanding, appreciation, and control of everyday environment and a preparation for later science courses. Present day general science had its beginning about 1905, and is now the most widely taught science. It has gained ground chiefly at the expense of physiology and physical geography. An investigation of representative texts shows that 41% of the physics taught in high school is taught in general science, 25% chemistry, 34% biology, 8% zoölogy, 17% botany, 20% physical geography. This is usually taught in 9th grade, yet when the individual sciences are taken up they are approached as entirely new subjects, producing laziness and carelessness among students who have taken general science. This can be avoided by outlining a science course to run through the entire high-school course. D. C. L.

Pasteur. (Editorial entitled "Worship Great Men.") JOHN R. KUEBLER. *Hexagon of Alpha Chi Sigma*, **16**, 11 (1925).—".....As chemists we are particularly concerned in our nation's welfare. More and more is the throbbing heart of industry finding itself dependent upon our basic science. More and more do we feel a great public stirring and rousing to a national consciousness of chemistry. It is our duty to meet this sentiment halfway—to become, as Mr. Russel expresses it in his article, liaison symbols to those who are unrelated to our field of endeavor. Chemistry is no longer a hermit subject and the success of the future chemist is going to depend to a great extent upon his ability to bridge his knowledge through himself to his employer and to his public. We can well take as a lesson unto ourselves the life of that great man, Louis Pasteur, whose gigantic shadow lies athwart civilization for all ages—a shadow not dark and terrible like many others wherein was bred the pestilence of death, famine or war; but a shadow, soft and quiet as twilight, soothing as a benediction in its amelioration of human anguish and suffering.

Pasteur's beginning was humble. His attributes were not the gift of fortune but rather grew with the man as he overcame obstacle after obstacle with a remarkable perseverance. He survived his difficulties.....Back of him lay the ages, foul with plagues and the curse of diseases but little understood. After him, a wonderful dawn of knowledge which grows brighter and brighter into a day of greater understanding of the ailments of the human race. More than that of any other scientist the name of Pasteur has become a household word.

From his life we learn three great lessons: (1) the value of method; (2) the value of friendship; (3) the value of humility.

His masterful technique acquired as a chemist and carried into the problems of biology resulted in a scientific epoch wherein he made known the true workings of fermentative processes, an understanding of many vicious maladies afflicting both men and animals and a knowledge of protection against such diseases or their effects.

He was devoted to his family and friends, patient under the whip of adversity, and above any mean jealousy toward his contemporaries. "Worship great men," he said. And well might *we worship* Pasteur.....

All of us—the rank, the file, the captains—have our zero hours—when perhaps the fruits of long achievements hang upon a thread, a turn of the hand, a vital judgment, or a little precious effort more monumental in the gathering than all the efforts of years... It is then that the little faith we have learned, the love which has strengthened us and the humility that has kept us close to earth among God's own creatures give us the strength to follow through.

"Worship great men.....

We should study and love our science as a living, breathing thing which has been handed down to us through the pulse beats of Lavoisier, Dalton and a score of others. The knowledge, the theories they have given us are but footprints in the field of science, inanimate, cold. Their names should be more than names to us.

"Worship great men.....

"For sometimes the spirit of reverence places upon the brow of the worshipper some attributes of the worshipped." B.

Local Activities and Opportunities

The Nebraska Academy of Science. On May 7, 8 and 9, at Lincoln, Nebraska, the Nebraska Academy of Science gave much more than usual attention to science teaching. The general session Friday morning, May 8, was given to two educational topics: "The Museum and the Education of Nebraska" by F. G. Collins, of the University of Nebraska Museum and "The Place of Science in Education" by Walter L. Locke of *The Nebraska State Journal*, Rabbi S. E. Starrels and Father John F. McCormick, president of Creighton University of Omaha.

Chemists in attendance were particularly interested in the address on "Enzymes and Plant Diseases" by Professor Geza Doby of the University of Budapest, Hungary. Papers in the chemistry section of special interest to teachers of chemistry were: "The Content and Scope of High-School Chemistry Teaching" by W. F. Hoyt of the Peru Teachers' College, "New Uses for Broken Electric Light Bulbs" by D. J. Brown and R. F. Tefft of the University of Nebraska and "Finding and Salvaging the Superior Student" by B. Clifford Hendricks of the University of Nebraska.

The chemistry teachers of the state were pleased when one of their number, Professor Joseph A. Moss of Cotner College, was elected to the presidency of the Academy for the coming year.

University of Nebraska. Doctor Charles Rodewald, instructor in the Department of Chemistry of the University of Nebraska for the past two years has accepted the position of Assistant Professor in the Department of Chemistry at Washington University. His work in the new position begins with the opening of the fall semester.

State University of Iowa. A regional meeting of the A. C. S. was held at The University of Iowa, May 8 and 9. Over 250 from Iowa and surrounding states were present.

The general meeting on Friday afternoon was addressed by Dr. James Norris, President of the American Chemical Society. He spoke on "Research and Industry." Dr. Roger Adams of the University of Illinois spoke on the "Asymmetric Dyes and the Mechanism of Dyeing." Dr. Phillip A. Shaffer, of Washington University gave a paper on the "Preparation of Insulin Protein." Dr. J. H. Matthews, of the University of Wisconsin gave an address on "Recent Developments in Photo-Chemistry." Following the banquet, Dr. Ira Remsen gave the principal address. Dr. Remsen in his usual happy vein told of the progress in chemistry since his early days in the laboratories of Germany.

Saturday morning was devoted to five group meetings. Of these the educational group proved unusually interesting. Dr. Ruch and Mr. Stoddard of the department of psychology of the State University of Iowa presented a report of their investigations on the Correlation of Aptitude Tests with Examination Records in Freshman Chemistry. Their results showed a marked correlation. They also brought out the practicability of a training test for those who offered chemistry for entrance as a means of placing them in college courses.

Dr. H. F. Lewis of Cornell College advocated a simplification of the curriculum in chemistry in colleges where the teaching force is too small to admit of specialization.

Dr. F. E. Brown of the Iowa State College reported a series of studies pursued during the past few years at Ames in which he showed that those who had had courses in high-school chemistry made higher grades than those who had not and that larger numbers continued in advanced work. This opinion was shared by a majority of those present.

The last paper on the program was read by Prof. F. C. Mortenson of Coe College on an "Introduction to Chemistry."

Mr. F. E. Goodell, associate editor of THIS JOURNAL, reported on the work of the Iowa Committee on Chemical Education. A very cordial feeling of coöperation was shown between the men of the larger institutions and those in the smaller colleges and high schools. The latter were strongly encouraged to undertake research work along lines adapted to their situations.

Yale University. Dr. Robert D. Coghill has just been reappointed to a research position in the division of organic chemistry at Yale University. Dr. Coghill is to be one of the research fellows under Professor Treat B. Johnson, who is directing research in tubercular bacilli. This tubercular bacilli investigation is supported by a special grant from the National Tuberculosis Association.

Columbia University. Professor M. T. Bogert of Columbia University has recently made a lecture tour through many of the large western centers lecturing on "Science and Art in the Perfume Industry." His tour was under the auspices of the St. Louis Section of the American Chemical Society and other scientific organizations.

Ohio Chemistry Teachers. The chemistry teachers of Northeastern Ohio are especially active in Chemical Education as is shown by the

following abstract circular letter which has been recently sent out by them:

Dear Chemistry Teacher:

"The response to the *Power's Chemistry Test, form B* has been wonderful. Fifty out of a possible seventy schools are to give the test; 2500 students are to be tested. The Northeastern Ohio Chemistry teachers are showing a wonderful spirit of coöperation on this first problem to be tackled. You will get the testing committee report in the fall, and will also hear of good work by the Committee on laboratory work.

"As a side-line to the rest of its work, the general committee, M. V. McGill, Lorain, C. E. Fleming, Sandusky, and K. M. Persing, Cleveland, are undertaking to compile a chemistry scrap book for the benefit of chemistry teachers of Northeastern Ohio.

"*This is what we want from you.* Often some teacher has devised a piece of laboratory apparatus that is cheaper, safer and better than those described in laboratory manuals or textbooks; or maybe you have put into operation some helpful suggestion from an outside source that has made you feel good; or perhaps you have found some new way of putting chemistry across effectively in the class room or laboratory. If you have, we want it. If the idea comes from something you have read, refer us to its source. If it is your own discovery, let us have it and give it publicity, through the JOURNAL OF CHEMICAL EDUCATION.

"We want to begin compiling this during the summer. Send in to any member of the committee any diagrams, descriptions or helpful suggestions for laboratory set-ups or teaching methods that you have found valuable. If they are not complete enough, we shall correspond with you. This scrap book is only possible through your coöperation and will be available for your use. It goes without saying that the better the coöperation, the more quickly the scrap book will be available. We want it to be wholly a Northeastern product.

"Plans are already under way for a real treat at the fall meeting, October 30th. Yours for a Chemistry organization that does something."

University of Maryland. Dr. Robert Calvert has accepted the position as Head of the Industrial Chemistry Division at the University of Maryland. Dr. Calvert has had eight years of industrial experience, approximately six with the DuPont and two with the Celite Co. He will take up his full duties with the opening of the fall semester.

Northeastern and Rhode Island Sections of A. C. S. The members of these two sections of the American Chemical Society united in an outing at the Riverside Recreation Grounds on Friday afternoon and evening, June 5th.

The program of sports included baseball, tennis, canoeing and swimming. Through the coöperation of the Chemical Warfare Service, airplanes gave exhibition flights in the afternoon. A smoke screen was produced with hand grenades. Motion pictures and an exhibition of Chemical Warfare devices were additional features of the entertainment.

Dinner and dancing in the evening completed a gala event for the A. C. S. members of eastern Massachusetts and Rhode Island.

High School Science. Analysis of a class of 576 students in Chemistry I at Syracuse University during 1924–25; shows that 270 high schools in 18 states were represented. 45 per cent of these students had had a course in high school chemistry, while 55 per cent had not; 65 per cent had had high school physics, while 35 per cent had not.

Unpublished Preparations for "Organic Syntheses." The suggestion has been made that "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, can increase its scope of usefulness by making available directions for preparations which have been submitted for future volumes.

The following is a list of some of the preparations which are now being checked by the editors. Those who wish a copy of directions for some of the listed preparations can procure the same by writing to Henry Gilman, Iowa State College, Ames, Iowa.

Acetamidine
Acrolein
Benzal pinacolone
Benzylaniline
m-Bromobenzyl chloride
o-Bromotoluene
α-Cyano-β-phenylacrylic acid
Cyclohexyl-bromopropene
Furoic acid
Hydroxylamine base
p-Iododimethylaniline
p-Iodoguaiacol
Mandelic acid
1-Methyl-2-pyridone
Myristic acid
Naphthaldehyde
Phenyl isothiocyanate
sym-Phthalyl chloride
Propionaldehyde
Pyromellitic acid
Pyrrol carboxylic acid
Thiophosgene
Thymoquinone
o-Toluamide
m-Tolylene diamine
Viscose

Rhode Island State College. The Second Annual Chemistry Week was held at Rhode Island State College from May 4–9, 1925. The general purpose of the week as a whole was to interest as many people as possible in the science of chemistry and its applications to our daily life. The number of persons to be interested was, of course, confined to those directly concerned with the welfare of the college, namely, the present student body and alumni and the general public

of Rhode Island. It is difficult to measure how successfully the accomplishment of this purpose was realized, but a brief description of the various activities of the week will indicate to what a varied extent those responsible for the plans went in their efforts.

A popular industrial and educational exhibit was held throughout the whole period. In addition to the displays sent in by manufacturers, the instructors and students in the department arranged quite a series of exhibits, the students participating in a contest for prizes offered by a number of manufacturers and dealers in materials of chemical interest. On the last day of the exhibit, because of the greater attendance at that time, a few industrial firms staged demonstrations. There was, for example, the water gas generator demonstrated by the Providence Gas Co., an exhibition of glass blowing by Mr. Bicknell of Macalaster Bicknell, Cambridge, and explanations of scientific apparatus by a representative of George L. Claflin Co., Providence.

As a means of interesting the general student body, the chemistry department of the college had secured the services of Harrison E. Howe, editor of the *Journal of Industrial and Engineering Chemistry*, who addressed the weekly assembly on the subject of "Chemistry in the Nation's Business." Those who have heard Mr. Howe will know that it is unnecessary to state in this connection what a splendid talk he gave and how much inspiration he brought to the chemistry staff and to those students more especially interested in chemistry.

On the following day Frank W. Keaney, instructor in the department, gave a popular lecture on "Liquid Air" before the student body and local residents and this ever fascinating subject, illustrated by simple experiments, proved one of the most successful features in connection with the week as a whole. On another evening, the students' Chemical Society held a banquet, with some Faculty members as their guests, and had invited the chemistry alumni of the college to return to renew old acquaintances and to view the exhibit. The coöperation of the chemistry alumni of the college had been previously secured by having them contribute towards a trophy, which was offered to the high school winning the annual chemistry contest. And moreover, several of the alumni had taken an active part in securing and arranging displays for the exhibit and for the museum of the department.

On Friday the R. I. Section of the American Chemical Society held its May meeting at the college, with about twenty of its members from the vicinity of Providence motoring to Kingston. After visiting the exhibit and dining at the college, the members listened to a lecture on "Optical Glass" by J. C. Hostetter, manager of the Central Falls plant of the Corning Glass Works. Because of Mr. Hostetter's unique experience in this subject and the many samples he had to illustrate his talk, this also proved to be a valuable feature of the week.

On Saturday was held the second annual chemistry contest for the high school students of Rhode Island, arranged for this time because of the large number of high school people at the college in connection with the Interscholastic Track Meet, an annual affair. Twelve schools entered 57 students in the contest and several series of prizes were offered to individuals and to teams representing the various schools. As a major prize, the Chemistry Alumni Trophy attracted the most interest, being a silver plated metal wash bottle on an ebony standard, and having to be won three years in succession by a school to be retained permanently by that school. This year the team from Pawtucket High School wrested possession of the trophy away from Rogers High School of Newport. And in so doing, the team incidentally won for the library of the school a number of chemistry books and for their teacher a year's subscriptions to a number of chemical journals. Second place was won by Rogers High School of Newport and third place by Technical High School of Providence, each school being entitled to a number of chemistry books and the chemistry teacher to a number of subscriptions to journals. The members of the team winning first place and the three highest scoring individuals also received books as prizes. All of these prizes were awarded at the same time as the awards for the track meet were announced and there seemed to be fully as much rivalry and excitement in the contest of brains as of brawn.

Copies of the examination used in this year's contest, as well as that of last year will be mailed to any person requesting same. And detailed information in regard to methods used in making ready the exhibit or carrying out the plans of this Chemistry Week will be gladly furnished by the head of the chemistry department of the college, Joseph W. Ince.

Recent Books

Chemistry for Secondary Schools. ERNEST L. DINSMORE, Boys' High School, Brooklyn, N. Y. F. M. Ambrose Co., Boston, 1925. VIII + 574 pp. $1.68. Forty interesting chapters; 545 pages of text; 207 illustrations, about half line drawings; 10 useful tables in the appendix; 16 pages of index. Printed on good paper, in clear type, and well bound.

This brand-new text is one which every teacher of chemistry in the preparatory schools should certainly look over very carefully; it will repay such inspection. Many strong poinfs are to be noted.

The book is copiously illustrated with reproductions of well-chosen photographs and with about as many clean-cut line drawings of apparatus, much of which is that used by the author. These drawings are especially noteworthy. Labelled arrows pointing to the different parts of the apparatus pictured, or to the materials used, make it apparently impossible for the dullest pupil to fail to get the correct idea of how the process described is carried out.

The book is thoroughly up-to-date, as shown by references here and there to items which have become current only within a comparatively short time. For example; the use of chlorine in the treatment of colds; the transmutation of mercury into gold as indicated by the work of Miethe; the preparation of war and industrial chemicals at Muscle Shoals and Edgewood Arsenal; the use of duraluminum in the framework of the Shenandoah; a simple but adequate presentation of the electron theory and its application to valence. I know of only one other recent book which gives so satisfactory a treatment of the electron from the high-school viewpoint.

Definitions of chemical terms are inserted in italics in connection with the term when it is first used. Where necessary, cautions to the student are given in italics, to guard against danger in experimentation.

While the most recent applications of chemistry are discussed as indicated above, the author has not neglected to emphasize fundamental principles. This is a strong point. For example, the preparation of acids is preceded by the statement of the general method; so with the preparation of ammonia; other instances might be cited.

The theoretical chapters begin to appear quite early. The Gas Laws are introduced in Chap. IV, Multiple Proportions in Chap. V, Gay-Lussac's and Avogadro's Laws in Chap. XII, Determination of Molecular Weights, including the use of 22.4 liters, in Chap. XIV. One is sorry, however, to see the electromotive series deferred until quite late in the book. The order of the descriptive chapters is about the same as in the average text, the gases being first taken up and then the metals. Qualitative Analysis is, happily, not included.

The treatment of Organic Chemistry is limited to one chapter following those on Carbon; there is also one chapter on Foods.

The descriptive matter in general is couched in language which the student can easily understand. The explanation of hydrolysis is an example of this; it is very well done.

In a first edition one may often expect to find a good many errors. So far as I have observed only two such have been found; an unnecessary coefficient on page 192; also one error of statement on page 174; cupric sulfide is stated to be formed when copper and sulfur are heated together; it should read cuprous sulfide. One regrets, also, that the old form of proportion, abandoned by the mathematics teachers, is retained for the solution of stoichiometric problems; but the author is in good company here since many recent texts still make use of the older form.

Occasional cross-references suggest to the student other paragraphs bearing upon the topics treated in the paragraph just studied.

Brief summaries follow each chapter. Exercises follow the summaries and are designed to test the student's ability to reason and to apply the knowledge previously acquired.

Ten useful tables in the appendix include; lists of names, common and chemical, of everyday substances; rules of solubility; physical constants of common gases and important elements; atomic weights, exact and approximate; and several tables of tests for positive and negative ions.

Taken as a whole, the book is certainly a strong candidate for popular favor and can unhesitatingly be recommended to teachers who are contemplating a change of text.

CHARLES H. STONE

Chemical Encyclopaedia. C. T. KINGZETT. D. Van Nostrand Company, New York, 1924. VIII + 606 pp. 15 × 22 cm. 3 ed. Price $8.00.

A very useful book is this third edition of the Chemical Encyclopaedia. It states the present knowledge on perhaps two thousand chemical subjects, in precise and condensed but, withal, accurate and conservative fashion. In useful information, it covers about what might be found in several separate works on inorganic, organic, elementary, physical and industrial chemistry.

Since emphasis is placed upon the industrial aspects of the elements and compounds, one looks with interest, for accounts of very recent developments in chemical industry. The result is gratifying. There are described, for example, the synthesis of methyl alcohol from the carbon monoxide and hydrogen of ordinary water gas, the production of camphor from turpentine, the use of insulin as an effective treatment for diabetes, and the improved gasoline containing tetra-ethyl lead to eliminate knocking. On the other hand, there seems to be no reference, under "aluminum sulfate," to its use in water purification or in sizing paper. Again, there is inadequate treatment of automobile lacquer, an industry of considerable proportions today.

That so few minor revisions might be made, is noteworthy, particularly in view of the author's adherence, in the thousands of paragraphs, to specific facts rather than indulgence in glittering generalities.

While the Encyclopaedia is chiefly of interest as a reference work on industrial chemistry, as an aid in answering a thousand and one questions on applied chemistry, there are many excellent sections on theoretical topics also. Reading of such articles as those on the atmosphere, the structure of the atom, isotopes, and respiration with its statement, for example, of the average daily amount of carbon burned and oxygen combined in the human body, should add alike to the interest of presentation in the classroom, and to the richness of the teacher's knowledge.

The alphabetical arrangement of the subjects is convenient. The language is well chosen. Altogether the book is worth having.

ROBERT CALVERT

Handbook to the Exhibition of Pure Science Arranged by the Royal Society. British Empire Exhibition 1924. The Macmillan Company, New York City. 228 pages. Price $0.90.

The title of this booklet is apt to sound forbidding to the casual reader. To all such, a series of delightful surprises will appear when the contents are investigated. In addition to the usual descriptive catalogue of exhibits—in itself furnishing most interesting and instructive reading—the whole first part consists of a series of excellent papers on present-day subjects of the greatest importance. Such a fund of accurate information has seldom been compressed within such a small publication. It is manifestly unwise to attempt to criticise a book covering such a varied field. The fact that every paper is written by an acknowledged world leader in his field of endeavor guarantees its excellence. This Handbook furnishes most enjoyable, helpful and authoritative reading. No teacher of chemistry or of any other science can afford to be without it. Following are the titles of the papers.

The Genesis of the Royal Society.
The Electron.
X-Rays and Crystal Structure.
Electricity and Matter.
Atoms and Isotopes.
Verification of the Theory of Relativity.
The Interior of a Star.
The Origins of Wireless.
Thermionic Values.
The Origin of Spectra.
Helium Gas and Its Uses.
The Principles of Fine Measurement.
The Circulation of the Atmosphere.
The Water in the Atmosphere.
Weather Forcasting.
Atmospheric Electricity.
The Origin of Man.
The Circulation of the Blood.
The Biological Action of Light.
Muscular Work.
Insect Mimicry and the Darwinian Theory of Natural Selection.
The Origin of the Seed Plants.

M. M. HARING

Report of the Division of Chemistry and Sanitation of the New Hampshire State Board of Health; Part III, Foods and Drugs. CHARLES D. HOWARD, State Chemist. Published by State Board of Health, Concord, N. H., 1925. 14 × 23 cm. 78 pp. Probably free to interested persons.

Though this pamphlet is far from a textbook in nature, it should greatly interest teachers as well as state and analytical chemists. Detailed data are given for the various substances investigated, including in many cases the trade names and the composition of the articles. Special attention has been given to problems of food sanitation, inspection of soda fountains and of roadside refreshment stands and articles sold by them, and problems of water supply and of sewage and garbage disposal of summer camps for boys and girls.

Articles most frequently examined were water, sewage, milk, non-alcoholic beverages, extracts, cream, ice-cream, butter, toilet preparations, washing and cleansing powders, and stove polishes. Attendant court cases and their disposition are frequently mentioned.

Other substances examined include: bread, candy, cocoa, cheese, eggs, flour, honey, maple products, milk products, olive oil, vinegar, ice-cream thickeners, miscellaneous foods, pharmaceutical preparations, proprietary remedies, liquid soaps, metal polishes, coal, enameled cooking ware, intoxicating liquors, and other miscellaneous articles.

W. SEGERBLOM

The Science of Everyday Life. EDGAR F. VAN BUSKIRK AND EDITH LILLIAN SMITH. Revised Edition. Cloth XIV + 498 pages. 13 × 19 cm. 240 illustrations. $1.60 Postpaid. Houghton Mifflin Company, New York.

This book is intended for seventh and eighth or ninth grade pupils. The authors have admirably adapted both material and method of presentation to these grades.

The book is divided into two main parts. Part I deals with the chief necessities of life and is simpler than Part II which treats of the forces of nature and their control.

Part I treats of air, water and food and how to use them. Each of these units is further subdivided into three or four projects. Each project is introduced by a series of problems which are experimentally solved either as a class demonstration or by individuals at home or in school. The pupil is told nothing that he can observe for himself and is expected to use his own judgment in explaining results obtained in the experiments. This is made readily possible by numerous questions bearing on the problems. Following the problems in each project is the reading matter divided into sections corresponding to the order of the problems. This is exceptionally well organized and is written in a very clear and interesting style. It is expected that a discussion of this reading matter will *follow* the performance of the problems. At the close of each project a number of individual projects and reports are suggested, directions for which are given in books, the titles and publishers of which are given. This bibliography constitutes a very valuable feature of the book.

Part II is organized in exactly the same manner as Part I. There are two units. Unit IV deals with homes and clothing. Under this unit are treated the building, lighting and heating of the home, and clothing and its care. Unit V treats of the work of the world. The projects cover common machines, electricity in the home, communication, radio, transportation and life—its origin and betterment. The project on radio is especially clear, complete and up-to-date.

The necessary equipment will be found in any fairly well-equipped school or could be obtained locally at very small expense.

Throughout the book no attempt is made to classify the material in line with the special sciences, though, when occasion arises, these sciences are referred to so that the pupil is made acquainted with their general content.

The most striking and commendable feature of the book is the eminently successful way it has combined the cultivation of the scientific attitude of the pupil with the furnishing of a fund of valuable information respecting the science of everyday life. It would be difficult to see how this could be done better. It is in this that its value from the standpoint of Chemical Education would chiefly lie.

On the whole the book is one of the best of the many texts in general science with which the market has been flooded during the past few years.

F. E. GOODELL